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POWER

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Make it Easy

THE executive's job is to get things done.

The way to get things done is to make it easy, convenient and agreeable to do them.

But many executives do not see, or at least do not practice, this easy way to do their job.

A service that requires the occasional manipulation of a valve will be more regularly and effectively performed if the valve is accessible and easy to operate than if it has to be reached with a ladder and handled with a bunch of waste.

It probably would cost less to put the valve in on the natural run than to bring it within easy reach. A valve with a common iron handwheel is less expensive than one of the ventilated or insulated type.

But the cost of a change in the piping or, if this is impracticable, of a safe and permanent approach to the valve would be returned in better service.

The extra cost of a better valve would be saved in time and effort of an employee, and time and effort cost wages.

The valve is only typical of the many chances around a power plant for making the job smooth and easy going or difficult and disagreeable.

Who does not know of cases where the crowding of a piece of machinery into insufficient space makes its operation difficult and its inspection and upkeep a task to be put off and avoided rather than an interesting item in the regular routine?

How much time and patience have been used up, how much apparatus injured and material spoiled for the want of proper tools!

The boss who would balk at spending a few dollars for tools and instruments to make the work of his plant operatives easier and more effective will often pay multiples of that amount in extra wages, in loss of efficiency and in shutdowns and rapid depreciation due to encouraged neglect.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Shall There Be More Three-Ring Circuses?

YEAR by year the annual meeting of the American Society of Mechanical Engineers becomes the center of an ever larger group of activities. Engineering organizations and trade associations in increasing numbers are holding meetings in New York during that week. So many committees and subcommittees sit at this time that the week is not long enough to accommodate them and they get in one anothers' way. And, to make the already brimming cup run over, there is the Power Show.

This great concentration of events important to the engineering world has certain advantages that it would be too bad to forego. To bring so many men of like interests into association results in an interchange of ideas and a spread of knowledge of enormous value. And, though there is no way of measuring it, an immense amount of business must have its origin in these contacts.

However, there must be a limit to the size to which this grouping can grow. If increase continues, the very advantages will be lost in the resulting congestion. The situation is somewhat analogous to that which developed in the circus business some years ago, where feature was piled on feature and attraction on attraction until the feeling of entertainment gave place to that of weariness in even the most enthusiastic small boy.

It will be well for engineers to avoid this pitfall and add no new events to an already over-full week.

New Combustion Cycles

THE recent International Bituminous Coal Conference at Pittsburgh presented to many of the engineers attending it a vision of what the power plant of the future may look like. Instead of the present form of boiler room where coal is converted directly into steam, they visioned a plant containing retorts, gas scrubbers, tar extractors and other equipment unfamiliar to the power engineer where the coal was processed before being used under the power-plant boilers. These boilers did not contain water, but a new liquid specially developed by the chemist to suit the requirements of the power plant and to improve its economy.

Even though many of the engineering problems have already been solved, it will probably be many years before this vision of the future will be realized, as the all-important question of its economic success has not yet been demonstrated. The warning sounded at the conference, that the success of such a plant will depend largely upon effecting a variety of small economies, and that in any event the margin of profit is small, should be considered before the development of such a plant is undertaken.

Accumulators for Central Heating Plants

ONE of the suggestions coming out of the discussions at the recent A.S.M.E. Meeting was the possible application of steam accumulators to central-station heating systems. These appear to be meeting with increased favor and are being extended in many of our large cities, not so much because of alluring profits, but because they provide a convenient supplement to centralized electric supply.

Such heating systems are often subjected to sudden peak demands. The plant must be located centrally to the service meters in order to minimize a necessarily high distribution cost, hence usually in thickly populated districts. When carrying over the peak loads, it is sometimes difficult to avoid stack nuisances. The steam accumulator would therefore appear to fit well into the picture.

Obviously, there may be in some instances local factors that would stand in the way of its application, but the suggestion seems worthy of further study.

Less Waste in Power Transmission and Application

WHEN power transmission was by mechanical means only, many devices were developed for easily connecting and disconnecting machines with the power source, which was usually a lineshaft. The ease with which electric motors may be started and stopped might create the idea that mechanical devices for starting and stopping the load no longer have a place in power transmission and application problems. Reading the article in this issue, "When to Use Clutches in Power Applications," will give quite a different picture.

During the last decade there has been a rapid increase in the use of clutches. This, in the main, has been due to a better appreciation of the economic value of these devices. But they also have a place in the safe operation of certain machines, and in the control of processes. Idle machines in a group require power for their operation even if they do no useful work. A clutch used to disconnect machines not required in operation, may save in a short time its cost in power requirements and give better machine-control.

Where there is danger of workmen being caught in moving machinery, the clutch has been found to be an effective safety device for disconnecting the machine automatically before the workman is seriously injured. Loads that are difficult to start may be more effectively handled, in many cases, by a clutch after the motor has been started without load. This arrangement may not only allow using a motor and control of smaller capacity, but it may also make possible the use of a more desirable type of motor for driving the load, in this way contributing to an increased efficiency in the application of power to the machine.

The power-factor problem in alternating-current power transmission and applications has almost unlimited ramifications. One of these brings the clutch into the situation. Where synchronous motors are used to drive machines that are in use intermittently, a clutch may be used to allow the motor to run continuously to correct the power factor, disconnecting the driven machine when it is not required to be in operation. These and other applications point the way toward less waste in power transmission and application by the use of clutches.

Two-Door Selling

CERTAIN materials and equipment purchased by industry fall clearly into one of two divisions, production and power services. Steam turbines, boilers, traps, unit heaters, pumps and blowers, to take a few examples, lie clearly within the power-service field, while automatic machine tools, paper machines, sugar evaporaters and oil stills are definitely in the province of the production man. Such products are naturally sold to the man responsible for power services or production, as the case may be. But many products are used both in production and in power services, and in such cases two doors lie open to sales effort. Clear recognition of this fact by manufacturers will increase both initial sales and repeat orders.

Take recording instruments, for example. The power engineer uses them for flue and feed temperatures, water and air pressures and innumerable other purposes from the boiler room out to the termination of his piping or ducts at the productive equipment. The production man can often use similar instruments in his process machines, vats and digesters. The instrument manufacturer can therefore approach the production man and the power engineer individually. Two doors are open to him; his chances of getting into the plant *somewhere* are doubled.

Once in, the instruments, if of superior quality, start to sell themselves. The production man on his rounds sees the instruments and asks the power man how they are working out. If the answer is favorable, the manufacturer may receive an unsolicited order from the production man—perhaps a year after a futile personal sales visit. In the same way effective instruments in the hands of the production man may sell themselves to the power engineer. The success of this internal reselling process depends entirely, of course, on the quality of the equipment; where quality exists it is very effective.

The train of circumstances may be tied in more closely with personal salesmanship. A satisfied power engineer, for example, is generally glad to give the salesman an introduction to his colleague in the production department.

Many products purchased by industry fall within this double classification. Conveying machinery, tanks, welding apparatus, cleaning materials, instruments, heat insulation, refractories, special alloys and other materials for severe service, packing, liquid-level indicators and preservative coverings are just a few. Makers and salesmen of such products should never forget the possibilities of the double entree, particularly where the quality of the product is such as to cause its use to extend within the plant once it has obtained a foothold at any point.

New Motors for Old

RECENT years have seen many changes in alternating-current motor designs that have greatly simplified and extended their applications. No longer is the use of induction motors limited to the general-purpose squirrel-cage type, with its comparatively low starting torque and high starting current, and to the wound-rotor type. The designs of squirrel-cage motors have been extended until there is now a type for practically every constant-speed application. Along with these developments, starting equipment has been simplified.

In many services the double squirrel-cage winding has replaced the wound-rotor. This change has decreased the cost of the installation and reduced the starting equipment to a simple switch for connecting the motor directly to the line. Increased reliability and reduced maintenance costs are other resulting advantages.

Where the general-purpose squirrel-cage motor was used, with reduced-voltage starting equipment, the high-reactance squirrel-cage type with across-the-line starting is now applied. Numerous applications of this kind formerly required over-size general-purpose motors to meet the starting requirements, with a resulting high cost for the motor and a decreased efficiency and power factor in operation. The high-reactance motor not only allows using the correct size of motor for the load, but, as the motor can be started by connecting directly to the line, it has made automatic starting the rule.

Synchronous motors have developed to the point where their starting characteristics are comparable with those of induction motors. Slow-speed ratings down to twenty horsepower are available, and synchronous-induction-type ratings corresponding to those of small and medium-sized induction motors. These developments have simplified the problems of motor control and the regulation of the system power factor.

These and other developments have made possible great savings in the application of power to industry. Nor are these limited to new installations. If an old installation is not satisfactory, the possibility of replacing it with modern and more simple equipment should be carefully considered. Many engineers are finding such changes to be highly economical.

When to Use CLUTCHES in Power A

Fig. 1—Friction clutch combined with a large wood split pulley

Both the pulley and clutch are made split so that the equipment may be installed on the shafting without disturbing the other equipment. Wooden friction shoes work against an iron friction wheel, being operated by a toggle-joint mechanism.

BY F. A. ANNETT
Associate Editor, Power

CLUTCHES are used for various purposes in power application. When loads are hard to start and the motor's starting torque is low, a clutch may be interposed between the motor and its load. After the motor has been brought up to full speed, the load is applied by means of the clutch. In some cases a clutch is placed between the motor and its load as a means of quickly disconnecting a machine from its power drive, to safeguard workmen. In group drives clutches are used to disconnect machines that are not required to be in operation, and in this way reduce the power consumption and the wear on the machinery.

Instead of the use of clutches being on the decrease, as is the general belief, the reverse is true. They are today so generally employed that there are few industries in which clutches cannot be economically used. Clutches of both the mechanical and magnetic types are extensively employed and may be used directly on the motor shaft or between parts of a group drive.

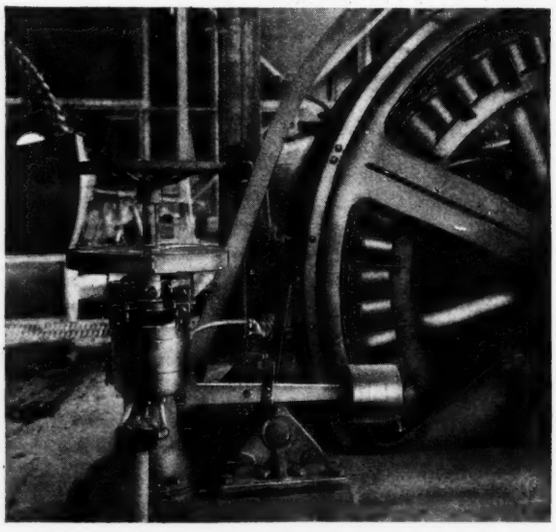
An example of a clutch on a motor is that used in single-phase machines of the split-phase type. These motors have a low starting torque, and where they are required to start under load, the rotor is connected to its shaft with a clutch. When power is applied to the motor, the rotor is free to rotate on the shaft. After the rotor comes up to near full speed, it is automatically connected to the shaft by a friction clutch and the load is brought up to speed.

The earlier types of synchronous motors had a low starting torque and it was quite common practice to use a clutch between the motor and its load. The clutch was used to apply the load after the motor had been brought up to speed. In some cases the clutch was also used as a safeguard to disconnect the motor from its load in case a workman became caught in the machinery. A notable example of such application is the driving of rubber calenders and refiners.

A synchronous motor of modern design, known as a super-synchronous type, has both the rotor and the stator mounted in bearings. At starting both are free to revolve, but as the stator is not retarded by the load it comes up to full synchronous speed and is locked into step. A brake is then applied to the stator frame and it is slowed down. As the stator decreases in speed, the rotor with its connected load is started and brought up to speed. When the stator has been stopped, the rotor is revolving at full synchronous speed.

This method of starting allows the motor to start and pull into step loads requiring a torque almost equal to the pull-out torque of the motor. The brake may be applied manually or electrically. Where electrical opera-

Fig. 2—Super-synchronous motor with automatic brake, driving grinding mill in a cement plant



Clutches of both mechanical and magnetic types are used for power transmission, in industrial drives and in power plants. Some of these applications are discussed and the factors to consider when selecting clutches are given, also hints on installation and maintenance of this class of equipment.

Applications

tion is used, the motor may be started and stopped by a push button, just as the conventional type is. This type of motor is used on centrifugal and other pumps without bypasses, air compressors and large blowers, pulverizing machinery in cement plants, machines that have heavy flywheel effect, machines that are hard to start when stopped loaded and similar applications. In Fig. 2 is shown a 600-hp. 150-r.p.m. 2,200-volt super-synchronous motor, with an automatic brake, geared to a cement grinding mill.

There is another type of synchronous motor, known as the clutch type, in which a magnetic clutch is built into the motor. In this type, Fig. 5, the rotor is free to revolve on its shaft, being mounted on roller bearings. At starting, the rotor, being free to revolve on its shaft, quickly comes up to speed and pulls into synchronism, after which the load is brought up to speed by energizing the magnetic clutch.

Fig. 3—A wood split pulley and clutch A form lineshaft cutoff coupling

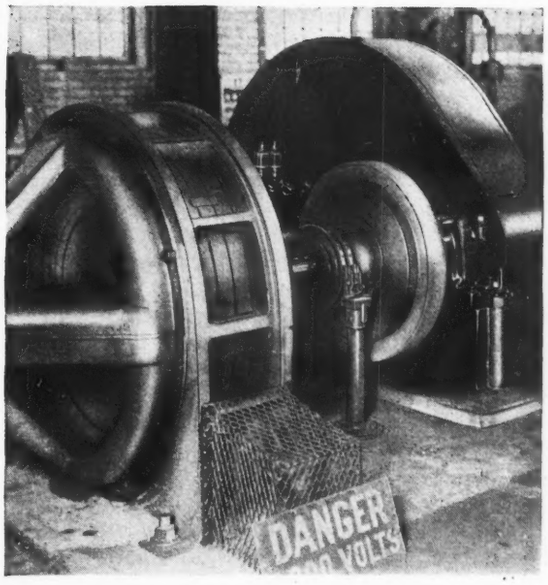


Fig. 4—Magnetic clutch on motor shaft replaced unloader valve on an accumulation

This synchronous motor is rated at 150 hp., runs continuously, and drives a reciprocating pump. The clutch is engaged and disengaged about every two minutes by an automatic pressure-regulating switch. This system allows the motor to run continuously for power-factor correction and at the same time save the power losses in the pumps when they are not required.

Starting of the clutch-type synchronous motor may be either by a manually operated or by an automatic-type starter. Either type may be used with either manual or automatic clutch control. With manual clutch control the motor starter is so arranged that the clutch excitation current cannot be applied until the motor has been connected to the line and its field circuit closed. Automatic clutch control takes care of this feature automatically when the motor is connected to the line and is running at full speed. This arrangement allows the load to be started and stopped at will without stopping the motor. The motor can be kept in operation for power-factor correction, even when the load is stopped, by opening the clutch exciting circuit.

This method of starting, as with the previously mentioned type, allows the motor to develop a starting torque equal to its maximum running torque, since the rotor is brought up to synchronous speed and fully excited before the load is applied. The current will be the same as if an equal amount of torque were exerted during normal operation.

The load is started without shock as the torque is applied gradually when the clutch coil is excited. The rate of acceleration of the load can be controlled by adjusting the clutch excitation current by a rheostat. By setting the clutch exciting current at a predetermined value, the clutch will slip during short overload peaks and thus prevent the motor pulling out of step.

From the foregoing it should not be concluded that the modern synchronous motor is not capable of developing a fairly high starting and pull-in torque. Motors of this type are available that will develop 150 per cent starting and over 115 per cent pull-in torque. These motors will, in case an overload pulls them out of step, operate as induction motors for five minutes and pull back into step if the load drops below 115 per cent full-load rating of the motor.

There are many applications for using a clutch on a synchronous or on any type of motor, other than for starting the load.

Instead of using the magnetic clutch in the motor, it is used extensively as a separate unit. Where a separate clutch is used, more space is required for the motor installation and in some cases an additional bearing is necessary. On the other hand, the separate clutch, whether magnetic or mechanical, is applicable to any type of motor and may be installed in any suitable place in the load. The separate clutch is also more accessible for inspection and adjustment. The unit magnetic clutch can be controlled in any of the ways that the built-in type can. Limit switches may be installed to control a number of operations and automatically obtain a complete cycle of operations. Pressure, vacuum and centrifugal-governor switch may be arranged to secure automatic starting and stopping of equipment. On large grinders a clutch controlled by a centrifugal-governor switch may be set to disengage when the load causes the motor to slow down below a predetermined value, and thus protect the motor.

In forced-draft fan applications where alternating-current motors are used, two motors are frequently employed to drive a single fan. One motor is of a size and speed to drive the fan to supply the draft for normal operation. For peak-load operation the small motor is disconnected from the line and the large high-speed motor brought into service. The high-speed motor is frequently connected to its load with a magnetic clutch so that it can be disconnected when not in use driving the fan. In other applications where two or more fans are driven from the same motor, clutches may be used to

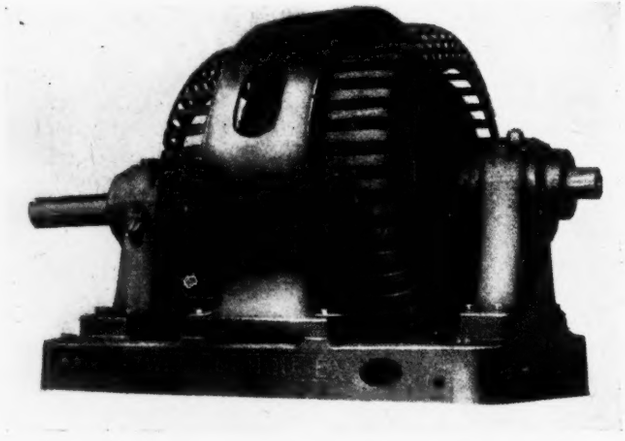


Fig. 5—Synchronous motor rated at 150 hp., 450 r.p.m. with built-in magnetic clutch

At starting, the motor is free to revolve on its shaft. After the motor has pulled into step, the clutch is energized and the load is brought up to speed. This method of starting allows the motor to develop a starting torque equal to the pull-out torque.

put the fans into or take them out of service as the air demands require.

On some air-compressor drives using synchronous motors, the compressor is connected to the motor through a magnetic clutch. This allows the motor to run continuously and correct the power factor of the circuit, whether it is driving the compressor or not. The clutch between the motor and compressor is automatically engaged and disengaged by a pressure-regulating switch. The pressure is thus kept between predetermined high and low values, without the usual unloading device.

On accumulator high-pressure pumps a clutch has been used between the motor and pump to replace the unloader valves. The motor runs continuously, and when the accumulator reaches a certain height, the clutch is opened automatically by a pressure-regulating switch and the pump stopped. When the accumulator drops to a predetermined height, the clutch is again energized and the pump is brought into service.

There are many other applications for both mechanical and magnetic types of clutches, not only for connecting motors to their load, but for dividing long lineshafts into sections so part of a group of machines, that are not required in service, may be shut down; also for connecting and disconnecting individual machines at will and for other purposes.

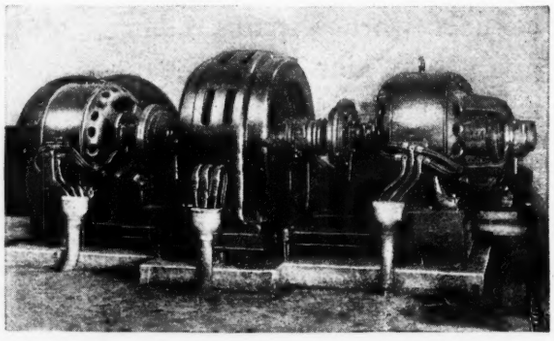


Fig. 6—Synchronous motor connected by magnetic clutch to two direct-current generators in a steel mill

This arrangement allows the generator capacity to be varied to suit the load requirements, and at the same time the full synchronous motor capacity is connected to the system for power-factor correction. Either one of the direct-current generators can be disconnected from or connected to the motor by the magnetic clutch.

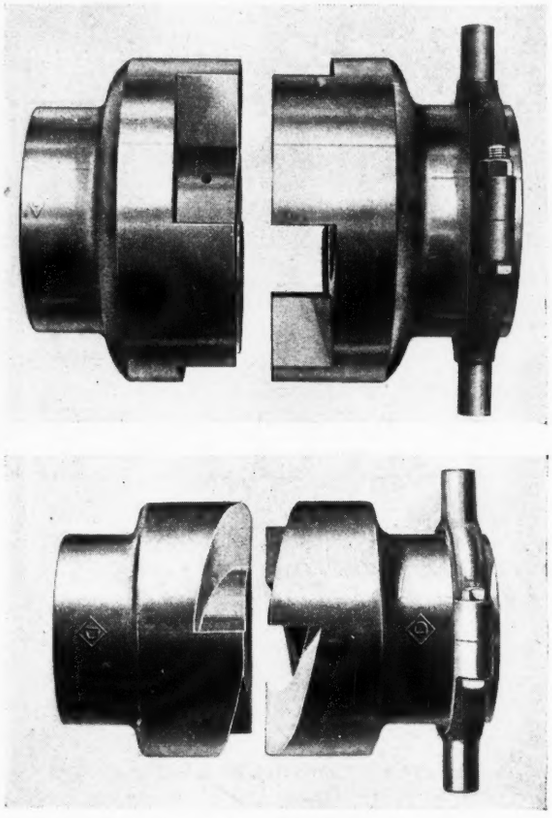
Mechanical clutches may be divided into two general classes, jaw and friction. The jaw type, Figs. 7 and 8, is so constructed that it does not allow slippage when it is engaged, therefore can be used only on slow-speed applications, for connecting load to a source of power. The square-jaw type, Fig. 7, should not be used on speeds above 40 r.p.m. and the spiral-jaw type, Fig. 8, for speeds above 60 r.p.m. when engaging under load. These clutches should be installed close to a bearing, as they pick up their load suddenly and there is therefore considerable shock. When the clutch is engaged with both halves at rest, the jaw type can be used for almost any reasonable speed. There are two features in favor of these clutches—their low cost and simple construction.

Friction clutches may be obtained for a large variety of capacities and speeds. For example, one line of clutches lists over fifty ratings between two horsepower at 100 r.p.m. and 300 hp. at 300 r.p.m. Some ratings include speeds up to 600 r.p.m. Other listings include clutches for ratings up to 1,500 hp. at 100 r.p.m. Usually, friction clutches can be obtained to operate at speeds about 50 per cent above the manufacturers' ratings, but they will require special balancing. High-speed clutches are also available in capacity ranges up to twelve horsepower at 3,000 r.p.m. and up to over 600 hp. at 500 r.p.m.

The power that any clutch will transmit successfully depends upon the character of the load. If the load is continuous and not subjected to sudden shocks, the ratings applied to the clutch are considerably higher than if the load is subjected to sudden changes. As an example, one clutch manufacturer recommends that for single-cylinder gas or gasoline engines a friction clutch of

double normal ratings be used, based on the same speed. For two-cylinder engines of the same type, friction clutches should have 50 to 75 per cent greater capacity and for three-cylinder engines 25 to 50 per cent greater capacity than normal is required. For four-cylinder engines the normal rating of the clutch may be used. This increased capacity of the clutch is required to absorb the sudden thrusts of the pistons at each explosion.

Also, when selecting a clutch the character of the load and the frequency of starting must be taken into consid-



Figs. 7 and 8—Jaw-type clutches

Fig. 7 (Top)—Square-jaw clutch can be used to connect and disconnect loads at speeds up to about 40 r.p.m. Fig. 8 (Bottom)—Spiral-jaw clutch can be used to connect and disconnect load up to about 60 r.p.m.

eration. If frequent starting under load is required, the temperature of the clutch may determine its capacity rather than its ability to carry a continuous load. Or if the load has a heavy flywheel effect or is difficult to break away, as a conveyor or roll train might be after standing in low temperatures, a considerably larger clutch may be required to start the load than is needed to drive it.

Manufacturers of machines not infrequently underrate the power required to drive them. In other cases machines require considerably more power to drive them after they have been in service awhile than when they are new or have been overhauled. Such abnormal conditions should be taken into consideration when selecting clutches, if trouble is to be avoided.

Where friction-clutch cutoff couplings are installed in lineshafts, they should be selected for the rating of the shafting rather than the immediate load to be transmitted. If the shaft is underloaded, it may be fully loaded at some future time, and the clutch should be large enough to take care of this load.

It is always advisable to co-operate closely with the clutch manufacturers, as their experience should put them in a position to give valuable assistance in selecting the proper size clutch for a given service.

The successful operation of a friction clutch, after the right type has been selected, depends upon proper installation and care. The shafting must be properly lined up. Because shafting is once in line, it does not follow that it remains so indefinitely. Changing loads on floors and other causes are likely to throw shafting out of line. More friction cutoff-coupling clutches in lineshafts have been damaged by improperly lined shafting than by any other cause. Where cut-off-coupling clutches are installed in lineshafts, they should have a bearing on each side.

The clutch should be kept clear, properly lubricated and adjusted. This attention should be given at regular

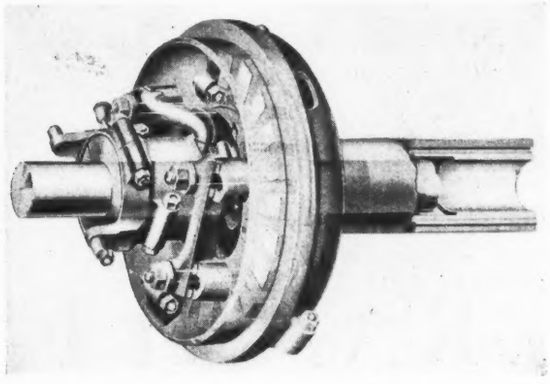


Fig. 9—Split-type friction clutch

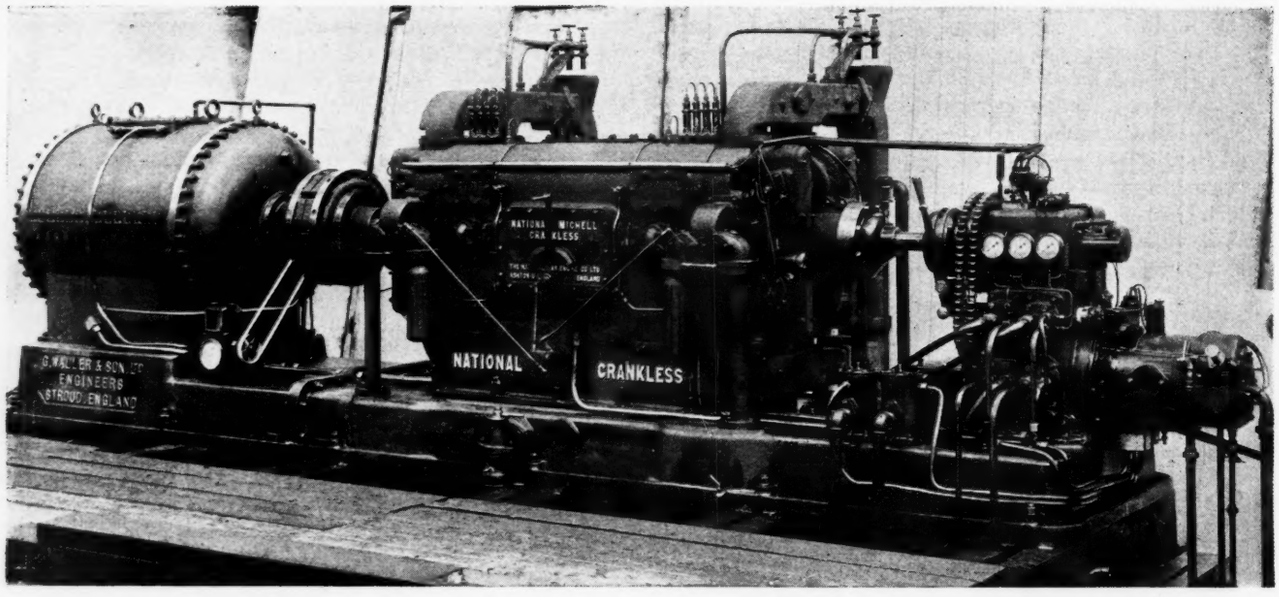
The split feature of this clutch allows easy installation upon a shaft without disturbing any other equipment. Any type of pulley, gear, sheave or sprocket can be mounted on the clutch sleeve.

intervals and not when someone happens to think that the clutch might need inspection.

For information in this article the author is indebted to the Dodge Manufacturing Company, Reeves Pulley Company, Cutler-Hammer Manufacturing Company, the Moore & White Company, General Electric Company, and Westinghouse Electric & Manufacturing Company.

OPERATING METHODS THAT SAVE

In the refrigerating plant, and boiler plants too, one of the big items of expense is the renewal of parts made defective by corrosion. Someone discovered that the degree of corrosion depended upon the number of hydrogen ions in the water. But how are these elusive ions to be measured? In next week's issue the article, "Reducing Corrosion by Hydrogen Ion Control," makes the whole process so simple that even the engineer's best girl can understand it.



CRANKLESS ENGINES
for Boosting Gas Pressure

BY LOUIS H. ROUILLION

RECENT equipment of the largest gas distributing system in Australia, the Australian Gas Light Company, of Sydney, includes twelve units of striking design for stepping up the city gas pressure. The installation is particularly interesting, because the engines and gas compressors employed are not of conventional construction, but embody the crankless type of design, which is being introduced into this country at the present time after intensive development abroad.

Each engine-compressor unit shown at top of page, consists of a booster (this being the term by which gas compressors used for this purpose have become known), driven by a gas engine through a flexible coupling. The engine uses as fuel a small fraction of the gas that is being boosted. The unit is thus independent of any source of power external to the gas company's system. Consequently, it can be located at any point on that system where a step-up of pressure is required, regardless of external considerations.

The capacity of the unit shown above is 500,000 cu.ft. per hour delivered against a difference of pressure between the intake and delivery mains of 7.2 lb. per sq.in., the speed being 750 r.p.m. For this duty an engine of 280 hp. was specified, but each of the engines actually supplied has a normal rating of 300 hp. with considerable overload capacity in reserve.

The engine is started by means of a 12-hp. three-cylinder gas engine, also of the crankless type, seen at the extreme right-hand end of the unit. This auxiliary engine is temporarily connected to the main engine shaft through a silent chain, clutch and gear box, the gear box containing also the lubricating pump, circulating pump and other auxiliary drives for the main engine.

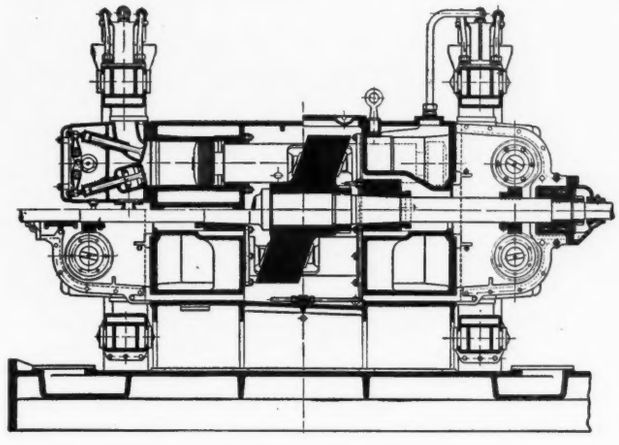
The engine, which is shown in cross-section, works on the four-stroke cycle. The particular feature of this engine is the elimination of the crankshaft and the substitution in its place of a slant member, or "wobble plate," mounted on the mainshaft. Eight cylinders are arranged in pairs equally spaced around the slant, and parallel to the shaft, instead of at right angles, as in the usual engine. Each pair of pistons is coupled together by means of a bridge and arranged so that the thrust is transmitted on either side of the slant by means of a Michell thrust slipper with a spherical seat. This arrangement produces a compact engine, reducing the mechanism between the piston and the shaft to the minimum.

At first glance one would think that the high periphery speed of the slant would make the engine inefficient. On the contrary, ideal conditions of lubrication are obtained by designing the thrust slippers according to the principle of wedge-film lubrication used in the Michell thrust bearing already successfully applied on marine steam and oil engines.

The booster compressor has twelve double-acting cylinders, each 12-in. bore by 9½-in. stroke. These cylinders, which are arranged in two groups of six at each end of the machine, have their axes parallel to the mainshaft and are equally disposed around the shaft.

Rigorous tests on the crankless engines have been undertaken and bear out their high efficiency. One of these tests, carried out by A. J. Gibson, of Julius, Poole & Gibson, consulting engineers, Sydney, Australia, on an eight-cylinder crankless gas engine rated 100 hp. at 750 r.p.m. and with a 5½-in. bore and a 6½-in. stroke, gave result shown in Table I. A second set of tests gave the the data shown in Table II.

The outstanding characteristic of the crankless type of engine is its dynamical balance. At all speeds the engine



Cross-section of the engine

is smooth running and distinguishes itself by the absence of vibration. Other features of the engine are its compact arrangement and the small space occupied, economy of headroom, and adaptability to multi-cylinder construction.

TABLE I

Brake horsepower	112.5	100	62.5
Indicated horsepower	125	112.2	77.2
Mechanical efficiency	90	89.3	81.2
Number of tests	5	11	3

TABLE II

Length of Test, Minutes	Average R.p.m.	Average Brake Hp.	Gas Consumed, Cu.Ft.	Brake Thermal Efficiency per Cent
42.5	751	102.7	1,335	28
70.5	756	100	2,200	26.8
39	630	85	1,018	28.2

Hydrogen Cooling System Increases Electric-Machine Capacity

UP TO 50 per cent more power can be handled by the same size electrical apparatus equipped with a new hydrogen system of cooling introduced by the General Electric Company. Use of hydrogen gas within a totally inclosed rotating machine has made possible this increase in capacity without raising the operating temperature beyond the point of safety.

The first commercial application of the new system of hydrogen cooling has been made with a synchronous condenser installed by the New England Power Company at its Pawtucket, R. I., substation. If the condenser were air-cooled, as are all others, its capacity would be 10,000 kva., but hydrogen-cooled, its capacity has been increased to 12,500 kva. With hydrogen at fifteen pounds per square inch gage pressure the machine could deliver 15,000 kva. without exceeding the normal temperature guarantees.

The advantages of hydrogen cooling are numerous. Not only is the capacity increased for a given size of machine, but oxygen and dirt are excluded by the airtight casing. Hydrogen will not support combustion, and fires of any kind, even from short circuits, are consequently impossible. Hydrogen also eliminates the effect of corona on the insulation. The usual air-cooled machine must be placed within a building, but the hydrogen-cooled equipment, being totally inclosed, can be placed outdoors, with a resultant saving in building cost. The Pawtucket condenser is outside the substation. The totally inclosed machine, being quiet in operation, can be installed in residential districts where noise might be objectionable.

In the case of air-cooled machinery there is considerable loss in operating efficiency because of the resistance of the air against the rotating element. Hydrogen is much lighter than air, and the wind resistance loss is reduced to about 10 per cent of the loss in air when hydrogen at atmospheric pressure is used.

The Pawtucket synchronous condenser is inclosed in a gastight, explosion-proof cylinder, Fig. 1, consisting of three main sections bolted together and provided with end bells. An extension on one end of the casing incloses the slip-ring mechanism. A carbon seal is placed around the shaft where it enters this housing, so that the brushes may be adjusted or replaced without losing hydrogen from the main shell. The bearings are supported by structural-steel frameworks welded to the inside of the casing.

Hydrogen, a good heat conductor, removes the heat much more rapidly than would air. The heat absorbed by the hydrogen is removed by four internal surface-type coolers, consisting of nests of pipes arranged concentrically inside the shell and close to each end of the casing, as in Fig. 2. Hydrogen is drawn in along the field structure by fans placed at the ends of the shaft and is forced radially outward through ducts in the armature laminations. It then passes back along the inside of the shell to the coolers, after which it is again drawn into the machine by the fans and recirculated. The cooler pipes are supplied with circulating water from the substation mains.

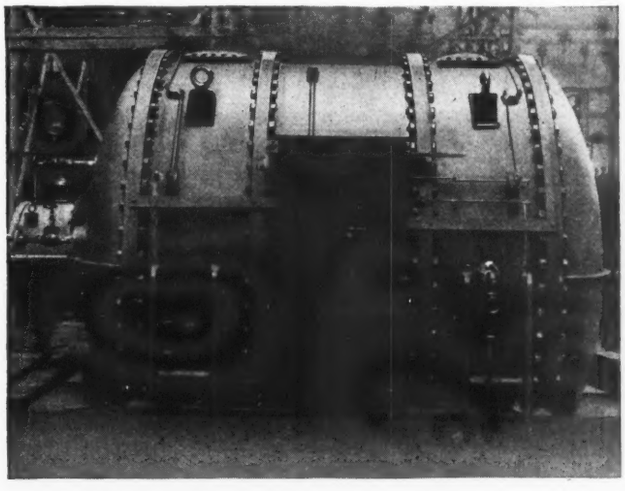


Fig. 1—Synchronous condenser inclosed in a cylinder and cooled with hydrogen gas

Full automatic operation is used with the condenser. A pressure-regulating switch and valve maintain the hydrogen pressure sufficiently above atmospheric pressure

so that leakage, if any, will be outward, thus preventing the contamination of the gas by air. A recorder in a cabinet attached to the casing gives a continuation indication of the purity of the gas and operates an alarm if the purity of the gas falls below 91 per cent. The casing of the condenser is so tight that the loss of gas is negligible, the replacement cost amounting to less than seven cents a day. The loss is made up by hydrogen automatically drawn from a commercial bottle of the gas connected to the piping system. Since a hydrogen and air mixture containing more than 70 per cent of hydrogen by volume is non-inflammable, there is an ample

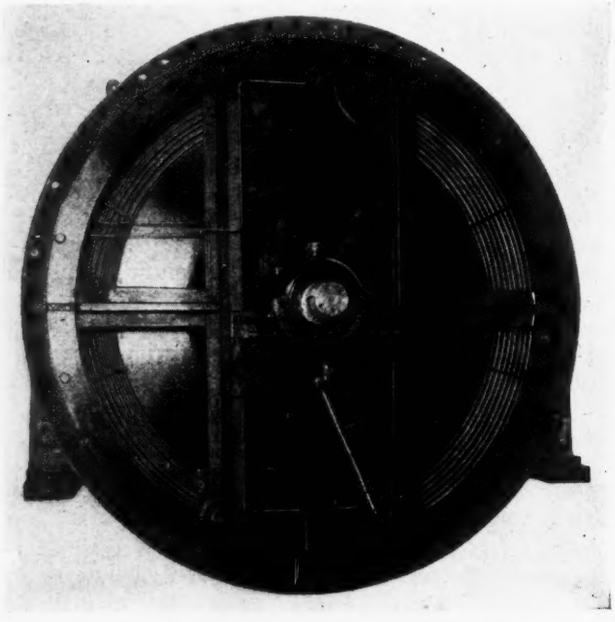


Fig. 2—End shield removed to show the nests of hydrogen cooling coils on the left and the right

factor of safety against ignition of the cooling medium. As an added precaution, however, the casing is strong enough to withstand the disruptive force of the most explosive mixture of hydrogen and air.

Other interesting features of the installation include oil-pressure starting and the use of indicating thermometers on the bearings. These thermometers operate an alarm if the temperature exceeds 140 deg. F. Another thermometer indicates the hydrogen temperature as it leaves the coolers and rings an alarm at 104 deg. F.

Hydrogen cooling of synchronous condensers has occupied the attention of engineers for a number of years. The General Electric Company has done extensive research work in this field, with a view of attaining its predicted advantages. The Pawtucket installation of the New England Power Company has already demonstrated that the principle of hydrogen cooling is both successful and economically sound.

A second installation of a hydrogen-cooled synchronous condenser is to be made soon by the Appalachian Power Company, a subsidiary of the American Gas & Electric Company. This will have a rating of 15,000 kva. in air and 20,000 kva. in hydrogen. It will be similar in design to the first machine. Considerable interest is also being shown by many power companies in hydrogen-cooled generators of large capacity. Several machines built recently have been so designed that hydrogen-tight casings may be added at a later date.

That B.t.u. Jargon

"Which," says *Power's* side partner, *Factory*, speaking of various unpleasant sensations, "is without a doubt much the way the factory manager feels when the power-plant engineer braces him with a recital of what he could do for an ailing coal pile if he only had a new thingumbob down in the boiler house. For the conversation soon gets all snarled up with boiler ratings, flue-gas temperatures and integrated steam-flow records. Right there a busy executive gets suddenly busier and maybe remembers he's fifteen minutes late already to an all-but-forgotten appointment. Which is the end of that.

"Somebody's fault. But whose? Show management how a new slat conveyor or gantry crane will save production time, sever a dozen strong backs from a long-suffering pay roll, and he's all ears. There, indeed, is the straight and narrow path to better and curlier pretzels, louder and funnier whammits—or name your own product. You're talking his language, hitting him right where he lives.

"But get to buzzing about kilowatt-hours and power factor, and the relation to the finished product—pretzels or whammits or whatnot—begins to partake of something of the dark blue obscurity of an institution of learning without a highly paid football mentor. For the plant manager finds it so easy to look on power, which more often than not is so many Ionian dithyrambs to him, as a distinctly necessary evil rather than one of the ingredients that go to make up the finished batch of pretzels or one of the costs of manufacturing smoothly machined whammits."

Factory is right! Who gains if the plant manager is frightened away (or bored to death) by a B.t.u. barrage? Talk his language and, in his own good time, he may come to talk yours. Industry is awakening to the fact that power has something to do with profits. So hang out the latch string, be yourself and let nature take her course.

Effects of Paint on Radiator Performance

IT HAS long been known that the heat emitted by a radiator is influenced by the kind of paint used on its surface. Many investigations have been made on older-type radiators, but until recently no test has been made of the effect of paint on the newer radiator designs.

The December issue of the Journal of the A. S. H. and V. E. contains the results of tests made on a modern ten-section four-tube cast-iron radiator 26 in. high to determine the effect of five kinds of paint.

Two identical radiators were used in the tests and were arranged to operate in unison under the same conditions. One of them was left unpainted to serve as a standard of comparison, while the other was coated with the paint being investigated.

Each radiator had its own electric boiler that supplied saturated steam at constant pressure. The heat input to each boiler was measured electrically, and by subtracting the boiler and pipe-line loss from the heat input, the heat emitted by the radiators was obtained.

The results indicate that only the final coat influences the heat emission. Considering the performance of the bare radiator as 100, the painted radiators compare as follows: Liquid gold, 92.6; aluminum, 93.7; white-gloss enamel, 102.2; flat-tone cream, 104; flat-tone brown, 104.8.

Boiler Room Records

SPOT LOSSES IN THE INDUSTRIAL POWER PLANT

By Howard W. Morgan
Combustion Engineer, Pittsburgh Coal Company

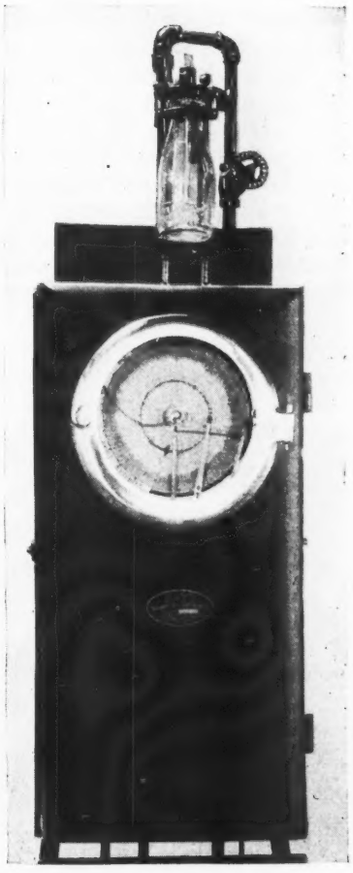


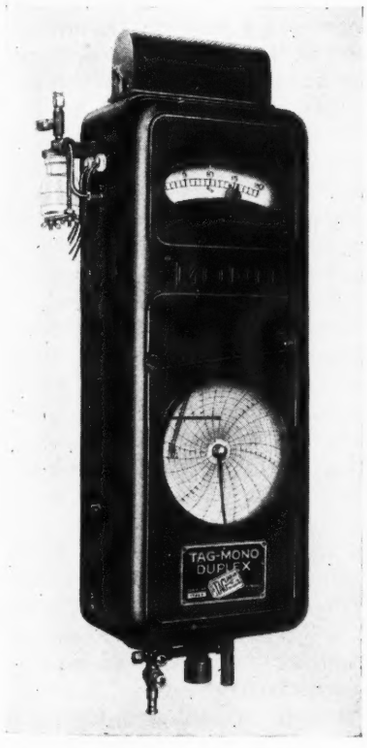
Fig. 2—An instrument indicating and recording CO_2

WE FREQUENTLY see descriptions with sample forms of systems for keeping records in the small power plant. I wonder how many of these systems are conscientiously followed and used for the only purpose they can possibly have in life—saving coal. If keeping records does not point the way to saving coal, what good are they?

Nearly every system that I have seen entails the keeping of the coal and water weights, yet every engineer knows how difficult it is for the small plant without adequate equipment to obtain anything like accurate figures for the coal consumed and the water evaporated.

But even assuming that these figures can be obtained accurately, do they tell the manager what he wants to know? He can see that during July the plant evaporated 8.5 lb. of water per pound of coal, while in June it was 8.3 lb. This shows progress, but should he be satisfied with 8.5 lb. or demand 10 lb.? He does not know.

Fig. 1—A simple instrument giving both CO_2 and flue-gas temperature



In August his record shows that the boilers evaporated only 8 lb. of water per pound of coal. Slipping back! So he invites the engineer in for a "conference." He learns that the poor showing can be accounted for by poor coal. No analyses are available to show how much poorer the coal is, but the engineer knows it was much higher in ash. Unfortunately, the weight of ashes was not recorded. It is then decided to weigh all the ashes removed from the pits in the future, but a compromise is made, and they count wheelbarrows. Nobody sees to it that every wheelbarrow is filled exactly the same. Nobody keeps a record of relative amounts of clinker produced or the effect of clinker on the amount of unburned coal in the refuse. Nobody samples the refuse to have it analyzed for unburned carbon, so when the quantity of refuse goes up nobody knows whether it is due to more ash in the coal or more coal in the ashes.

Now if a simple system of records could be devised that would do away with all the uncertainties in keeping approximate coal, water and refuse weights and would at the same time tell the boss what he wants to know, there is no doubt that it would pay.

Obviously, the first thing to decide when you start out to install a record system is what you want to know. Although this is obvious, it seems to be frequently overlooked. What does the boss want to know? Does he care whether the evaporation was 8.3 lb. or 8.5 lb? Not unless he knows whether it should have been 8.6 lb. or 9.6 lb. And how many managers know?

If I were the manager, I think what I would want to know would be how much coal is being wasted in the boiler room and how can I stop it. I would look to the leaks—the losses. When I figured that my losses were about as low as I could hope to keep them, I would know that my evaporation was about as high as could be expected and I would not care whether it was 8.5 lb. or 9.5 lb. of water per pound of coal—so long as I was sure it was the last drop I could hope to squeeze out without paying more for it than the drop was worth.

Now, instruments are on the market that will record with necessary accuracy all the information required for calculating the biggest controllable loss—the loss of heat in the dry flue gases. All that it necessary are a CO_2 recorder and a recording thermometer connected to the last pass. It is not even necessary to calculate from these instruments the amount of the dry flue gas loss, as it can be determined in advance what these instruments should read for a reasonably low stack loss under the normal operating conditions.

A boiler meter that shows steam flow and air flow instead of CO_2 will do as well and has the advantage of showing the variations in steam demand that may account for variations in flue-gas temperature. As this meter can also carry a flue-gas temperature pen, one chart gives all the information needed to enable the manager to keep tabs on the one big controllable loss.

The only other losses that are directly under the operator's control are the loss due to heat carried away in the blowdown water and the heat lost with unburned carbon in the refuse. If the blowdown valves are tight and not continuously leaking hot water to the sewer and a regular schedule of blowing down is adopted, the former is not likely to be anything to worry about. The latter can be checked by having occasional analyses made of composite refuse samples. These samples should be collected by someone other than the regular boiler-room operators.

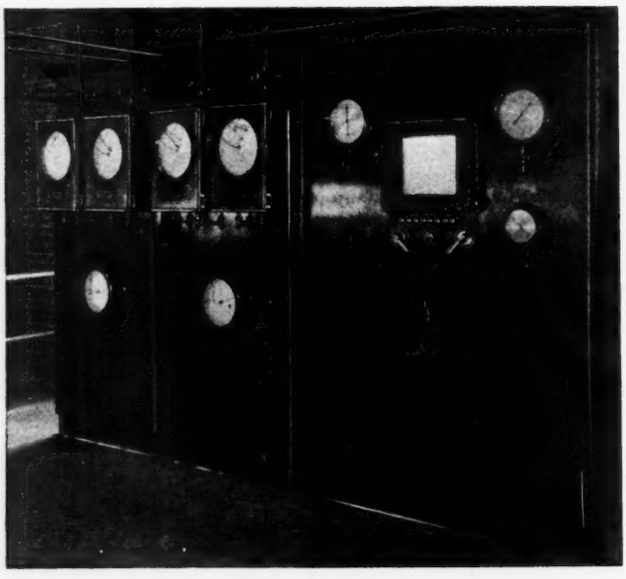


Fig. 3—Steam-flow air-flow meters in the boiler room

A limit for allowable unburned carbon in the refuse can be established and an investigation made whenever it exceeds these limits.

This system of checking losses is not offered as a complete system sufficient for any power plant, but as a simple system for the small plant which is not justified in installing accurate coal-weighing equipment in addition to the instruments. Between coal and water weights only and the data for computing the dry flue-gas loss and the refuse loss, I would choose the latter, as it points the way to improvement. It enables me to lay my finger on the sore spot in the operation.

The loss in the transportation and use of steam after it is made is another matter.

Boiler-room instruments are often condemned because in so many boiler rooms they are there but not functioning. This is entirely the fault of the management. If nobody wants to see the charts, there will be no charts. The average small industrial boiler room, particularly if it is carrying a heating load only, is not in charge of a high-priced executive. The man in charge may be conscientiously striving to save coal, but he is human and cannot forever take a keen interest in saving money for the company unless the company shows a little interest. Someone higher up should receive the charts and comment on them—a little praise when they are good and a little "hell" when they are not so good.

Under such circumstances modern instruments will work and keep working. The charts from a well chosen group of instruments will tell the manager more of what is good for him to know than even the most accurate coal and water weights, when these are not accompanied with complete combustion data, including coal and refuse analyses.

The point I am trying to get across is that it is fairly easy to compute combustion losses, that in the case of the biggest loss instruments are available to give the necessary data, and that when the manager knows that the combustion losses are as low as can be expected, he can sit back well satisfied, whether the evaporation is eight, nine or ten pounds.

If the losses are as low as can be expected, naturally the evaporation will be as high as can be expected. It seems axiomatic to say "when you want to save, look to the losses," and yet there are, literally, hundreds of boiler plants operating in this country, the losses from which are known to no one.

Watch the Outside Surface of Your Boiler

By I. S. Chamberlain

IN A recent discussion concerning power plant operation in general, mention was made of the account that appeared in *Power* a few months ago, describing the failure of a Stirling boiler caused by corrosion of the outside of the blank head of the mud drum, and question arose as to why the defect had escaped notice before the accident.

It is not the intention of this article to infer any lack of co-operation between operating engineers and boiler inspectors, and I am pleased to state that during a period of nearly five years in which I was employed as a boiler inspector by a leading insurance company, I can recall no instances where my recommendations made in the interest of safe and proper operation of boilers and other pressure vessels were not cheerfully received and accordingly acted upon by those in charge. In every case where recommendations were made for altering the brick settings of Stirling boilers so as to permit thorough inspection of the blank heads of mud drums, the engineers agreed that the change should be made, the owners making no objection to the expense of meeting this requirement.

It is conceded, as argued by many, that the duty and purpose of a boiler inspector is to locate defects, if possible, which the operators may have overlooked in the course of their work on the boiler. However, it is strange that some engineers who appear to exert every effort to keep their plants in first-class condition and pay particular attention to the matter of boiler cleaning, will stop just short of knowing the extent of corrosion on the external surfaces of their boilers.

In several plants when boilers are inspected the internal surfaces are always found so entirely free from scale and in such excellent condition in general, that the men in charge of these plants are justly proud of being able to exhibit them. Boiler inspectors naturally find it a pleasure to visit plants of that description, where the efforts of the operating force to keep the equipment in proper condition are so manifest. However, it has been

found in some of those plants that the whole matter of external corrosion has been practically overlooked.

Many boilers in older installations were found with the blank head of the mud drum solidly bricked over; others, of the horizontal water-tube type with large cast-iron mud drums, had been set with the tops and backs of the mud drums bricked over, making it impossible to see these parts without removing considerable brick, which was usually masoned up securely. It seems significant that when boilers set in that manner are prepared for an inspector's visit, rarely is any action taken toward removing the concealing brickwork until such removal is requested by an inspector. Inasmuch as the condition of these heads, drums, etc., cannot possibly be determined with any degree of accuracy as long as they are concealed from view, it appears in some cases that the same engineers who put forth special effort toward the proper care of the internal surfaces of their boilers, are content to go along without the slightest idea of the condition of external surfaces. This trend is also shown in cases where the tops of mud drums on the Stirling type of boilers are left buried under deep accumulations of soot when the boiler is declared ready for the inspector.

Blowoff pipes on horizontal tubular boilers are sometimes regarded in much the same manner. On some old installations the horizontal run of the blowoff pipe is beneath the brick floor of the combustion chamber and therefore concealed. It is the common custom to remove the covering from the vertical section of the pipe, between the boiler and the floor, leaving the horizontal section buried and inaccessible, and in quite a few cases nobody at the plant knows how long the pipe has been in use. Yet the inspector is supposed to possess some magical power which enables him to know what condition the buried section is in.

Corrosion Caused by Drippings

Drippings from leaky pipes or valves over tops of boilers is another source of corrosion that is sometimes neglected.

In one instance a leak developed at the calked edge of the blowoff flange on the shell of a self-contained boiler of the Economic type. The boiler was set in such a position that it was rather difficult for a man to get under the shell, there being scarcely sufficient room to install the connections on the blowoff line. While making an inspection of the boiler about a year after it was installed, the inspector noted evidence of leakage around the blowoff flange. A thorough inspection revealed that the leak had cut a groove nearly one-half inch wide along the bottom of the shell, extending on a radial line from the flange for a distance of about one and one-quarter inches, the shell thickness being reduced about 30 per cent at the deepest part of the groove. It was plain that here was another case of the external surfaces of a boiler being overlooked in favor of the inside portions, which were found clean and in good condition.

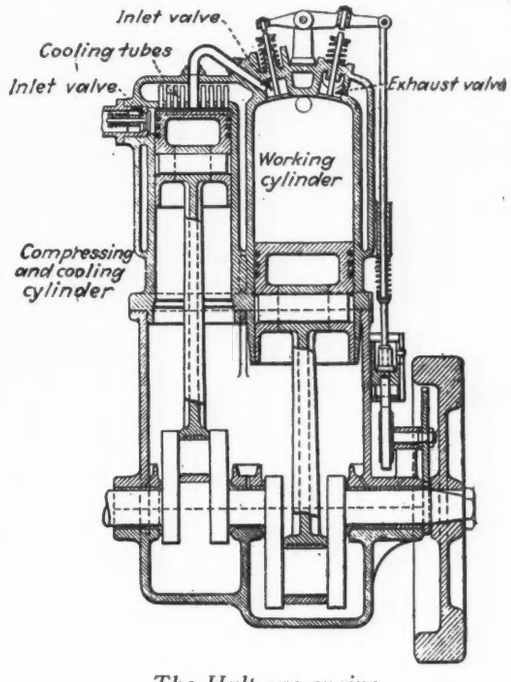
Vertical boilers mounted on locomotive cranes and other portable machines of that type are quite often seriously damaged by the corrosive action of wet coal which is left lying against lower portions of the boiler shell. The lack of room on these machines necessitates close grouping of various parts, the coal boxes, water tanks, etc., being set against the boiler. These coal boxes are usually steel tanks, rectangular in form, and are placed in a corner of the cab, or housing. Thus an open space is left between the boiler and the rear of the tank, which space is soon filled with coal spilled over when loading the coal tank. This space, in the usual construction, is almost inaccessible, making it rather difficult to remove the accumulation of coal, but if it is not removed, the light steel jacket over the boiler lagging soon corrodes away, the lagging disintegrates, and a mass of damp coal is left packed against the hot boiler shell. The corrosive effect of such a condition is easily seen. various cases of this kind have been found where it was necessary to make expensive repairs or scrap the boiler long before any such action should have been needed.

The subject of external corrosion of boilers in general seems to be one that has not received its due share of attention. As the damage and expense from this source can so readily be prevented in many instances, it is to be hoped that the matter will be taken up wherever it is needed.

The Hult Gas Engine Cycle

A NEW cycle for internal-combustion engines has been invented by O. W. Hult, Aktiebolaget Archimedes, stockholders, embodying a novel plan of cooling the air charge.

As shown in the illustration, reproduced from *The*



The Hult gas engine

Engineer, this engine is provided with an air pump. On the pump's compression stroke the air is forced into a nest of cooling tubes where the heat of compression is removed. On the next downward pump stroke the air expands above the retreating piston and, in so doing, is cooled below the atmospheric temperature. The inlet valve of the working cylinder now opens and the cooled air is forced into this cylinder, along with the gasoline charge which enters the air stream at the inlet valve.

The cycle gives a denser air charge, permitting the burning of more fuel per stroke. It also enables a higher compression ratio to be carried before preignition occurs, for the initial air is cooler than is usual. The thermal efficiency should be higher than in the standard gasoline engine. The same principle can be used for natural-gas engines and possibly for Diesel oil engines.

COMPOSITION . . . TEMPERATURE . . . TECHNIQUE

The Keys to
Good Babbitt Bearings

By James Silberstein
Metallurgical Engineer, Chicago, Ill.

BABBITT metal, commonly used for lining bearing shells, was named after Isaac Babbitt, who in 1839 invented and used an antifrictional metal for bearing linings. His original alloy consisted of 89.3 per cent tin, 3.6 per cent copper and 7.1 per cent antimony. Since then many other babbitt metals have been put on the market, but the best grades used at present have a chemical composition not much different from the original formula.

Babbitt metals can be divided into two classes—the tin-base or genuine babbitts, and the lead-base babbitts. They usually contain a minimum of 80 per cent tin or lead, respectively, as their fundamental element, with additions of antimony and copper and, in the case of lead-base babbitts, of tin.

Tin-base babbitts are relatively expensive. They are harder, have a greater compressive strength and are more able to resist shock than the lead-base alloys. They have a wide range of working temperatures, rendering them foolproof in handling. They can therefore be recommended in cases where the babbitting is difficult to supervise. A tin-base babbitt has an average weight of 0.263 lb. per cubic inch.

Lead-base babbitts are comparatively cheap. They are not so hard and do not have so high compressive strength as the tin-base alloys. They have a comparatively narrow range of working temperature and therefore require more care in the babbitting process. They have an average weight of 0.37 lb. per cu.in., and it thus requires 40 per cent more metal to line a shell with a lead-base babbitt than with a tin-base.

Tin-base babbitts are used in high-speed machines where the service requires a shock-resistant bearing lining. Such cases are railway and automobile motors. Where high speeds and comparatively few shocks are encountered, as in many industrial motors, or for low-speed service, as for instance in railway car journal bearings, lead-base bearings are used.

A babbitt metal must be sufficiently soft to adapt itself to the shape and the movements of the rotating shaft and take up and distribute the load uniformly. On the other hand, it must have a certain degree of hardness, so as to insure good wearing qualities. All babbitt metals are more or less brittle; excess brittleness is, however, undesirable, since the babbitt metal is liable to crack and break, with the result that the bearing tends to run hot. A lead-base babbitt containing 13 to 20 per cent antimony with little or no tin is, on account of its great brittleness, very inferior to a lead-base babbitt containing the same amount of antimony and 8 or 10 per cent tin.

For example, good lead-base babbitt had been used for babbitting sleeve motor bearings. The process of babbitting was changed from still casting to centrifugal casting to save time and labor. After the change had been made, it was found that every bearing, babbitted according to the new method, ran hot on the test floor. Investigation showed that every lining that had been cast centrifugally had segregated, so that practically pure lead was next to the bearing shell, while the section of the lining that was in contact with the shaft consisted almost entirely of very hard and brittle crystals of antimonial tin. Antimony and tin have nearly the same specific gravity, while lead is much heavier and separation took place due to the centrifugal action.

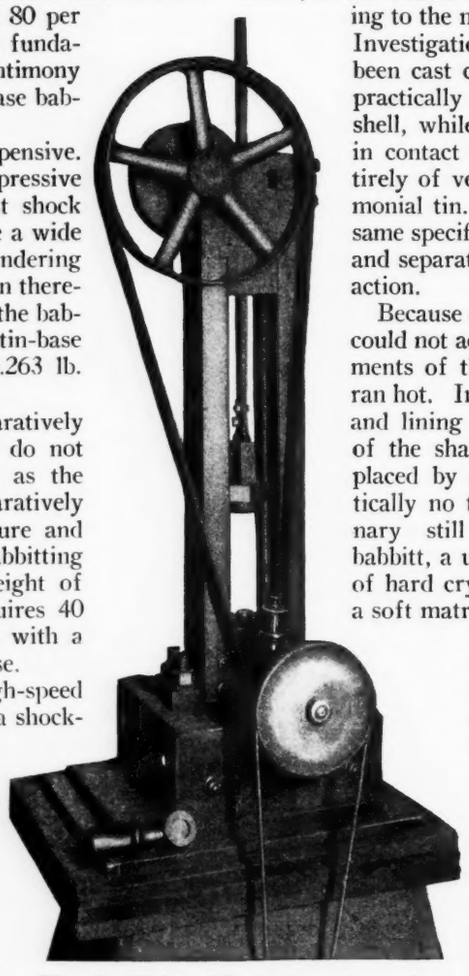


Fig. 1—With this device the resistance of bearing metal to shocks and pounding can be determined

Because of the excessive brittleness the lining could not adapt itself to the shape and the movements of the shaft and the bearing, therefore, ran hot. Increasing the clearance between shaft and lining resulted in vibration and pounding of the shaft, so the lead-base babbitt was replaced by a tin-base babbitt, which had practically no tendency to segregate. Under ordinary still casting conditions of lead-base babbitt, a uniform lining is obtained, consisting of hard crystals of antimonial tin embedded in a soft matrix of lead. This structure is capable of both conforming itself to the shaft without cracking and taking the wear, while an excessively hard or an excessively soft lining is disastrous.

Testing of Babbitt Metals

There is really no method of testing that allows us to forecast the behavior of babbitt in service except actual service tests. These are, however, expensive and require a long time. To a certain extent the value of the babbitt can be determined by its chemical composition, its hardness and its resistance to shocks and

pounding. The chemical analyses of tin, or lead-base babbitts should not show the presence of zinc, aluminum or any other deteriorating elements. A tin-base or genuine babbitt may carry a small percentage of lead, which should, however, not exceed 2 per cent. The copper content of a genuine babbitt generally ranges from 3 to 5 per cent and should not exceed 8 per cent, since

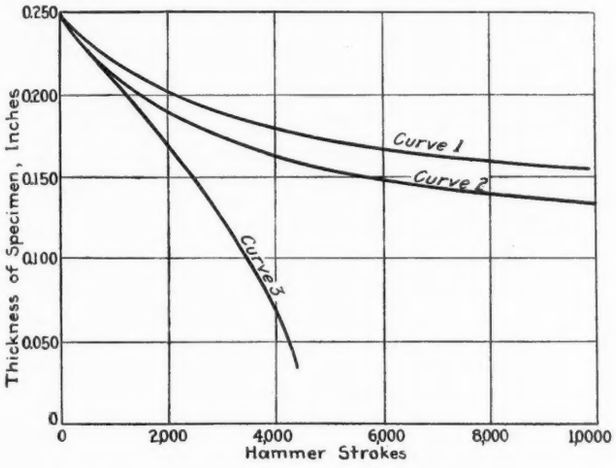


Fig. 2—These curves show the effect of shock on different grades of babbitt

a high copper content results in difficulty in handling. Arsenic is allowable up to one per cent in tin-base babbitts.

A lead-base babbitt may carry up to 30 per cent tin. Tin up to 10 per cent is beneficial in lead-base babbitts, but it is questionable whether an increase in tin over this percentage gives a benefit equal to its cost. The experience of several large users indicates that, if a lead-base babbitt containing up to 10 per cent tin is not satisfactory, a strict tin-base babbitt should be used. Copper may be present in lead-base babbitts, but should not be present in greater amounts than one per cent, since it increases the brittleness of the babbitt and causes difficulties in handling. Arsenic up to 0.5 per cent may be present in lead-base babbitts. Nickel is of no benefit in either tin-base or lead-base babbitts.

The hardness, generally determined by Brinell test, should vary between 22 and 32 Brinell (at 500 kg. pressure). The resistance to shocks and pounding can be determined by subjecting the babbitt to a series of hammer blows, using an apparatus as shown in Fig. 1. The effect of hammer blows on test pieces of different babbitt metals, the test pieces having a diameter of 1 in. and a thickness of $\frac{1}{4}$ in., is shown in Fig. 2. Curves 1 and 2 indicate good grades of babbitt, while curve 3 shows that the babbitt in this case is soft and brittle and consequently not suitable for severe service.

The Babbitting Process

Casually watching a workman pouring babbitt metal into a bearing shell does not impress the observer that it requires any skill on the part of the operator. Neither does this operation seem to be such as to require any special attention or careful supervision. However, this impression is misleading, for to produce reliable and dependable babbitted bearings the workmen must be trained, temperatures kept within fixed limits, and the tinning process and handling of the shells, mandrels and metals must be given careful study and consideration.

Poorly relined bearing shells are probably the principal cause of bearing failures. An improperly or carelessly babbitted shell gives short life in service and is likely to develop one or all of the following difficulties:

Babbitt lining works loose.
Oil creeps in between the lining and the shell.
The lining, being poorly supported, cracks.
The babbitt breaks away from the shell, causing excessive play.

The bearings, under the above conditions, tend to run hot.

In babbitting bearings all operators seem to follow the same practice; but there is a universal tendency to neglect details in connection with such points as follows:

1. Properly cleaning, tinning and preheating of bronze shells.
2. Preheating of mandrels and shells before babbitting.
3. Correct temperature of the alloy.
4. The handling and pouring of the babbitt in bearing shells.

Cleaning, Tinning and Preheating of Bronze Shells

Oil, dirt and grease should be carefully removed from the machined surfaces that are to be babbitted. The machined surfaces that are not to be babbitted should be coated with a thin mixture of clay and water. The parts to be babbitted are then swabbed with a flux consisting of a saturated solution of zinc chloride in hydrochloric acid. The shell is then dipped into the tinning bath. The tinning alloy consists of half-and-half solder, which is melted in a steel or iron pot and maintained at a temperature between 750 and 890 deg. F. If no pyrometer is available, this temperature can be judged by immersing

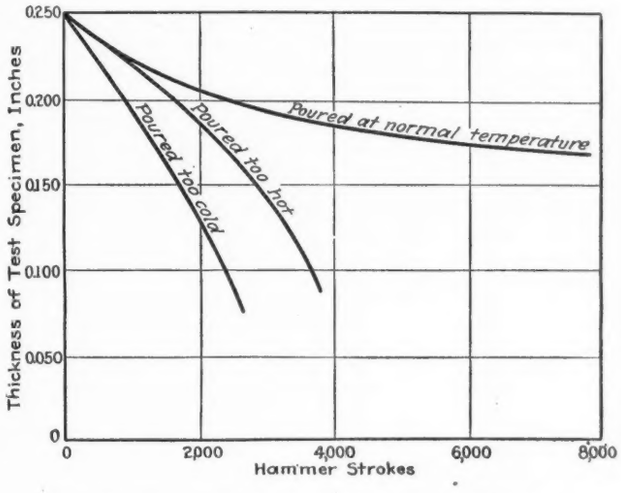


Fig. 3—The method of applying the babbitt has a distinct influence on the behavior of the bearing, as is shown by these curves

a pine stick into the metal bath, the right temperature being obtained when the stick chars but does not burn.

The shell should be left in the pot until it is just hot enough for the tinning alloy to run off, the shell being thereby preheated to the right temperature for babbitting. The shell is removed from the pot and the parts to be babbitted and again rubbed with the flux, making sure that there are no untinned spots left. To remove the flux, immerse the shell again in the pot and do not swab or otherwise touch the tinned surface but babbitt immediately.

It is not common practice to tin iron shells, although it can be done. Generally, anchor holes are depended upon to hold the babbitt securely to the shell. All anchor holes should be cleaned well so that the babbitt is held firmly in place. Iron shells should then be preheated until they are just hot enough to cause a bar of solder or babbitt to melt when held against the shell (corresponding to a temperature of 380 to 450 deg. F.).

Preheating shells is very important in babbitting practice. Since moisture from the air condenses on a cold shell, the result of pouring babbitt into a unpreheated shell would be an explosion, caused by the sudden formation of steam. Such explosions have repeatedly proved fatal. Furthermore, the pouring of babbitt into an unpreheated shell results in the babbitt shrinking away from the cold metal and thus becoming loose.

Heating Mandrels for Babbitting

To prevent chilling of the babbitt when poured, mandrels should be heated to the same temperature as the shells, the correct temperature being determined in the manner just mentioned. Before babbitting the mandrels should be coated with a thin wash of clay mixed in water to prevent the babbitt from sticking to the mandrels. The coating can be applied with a brush or a swab.

Babbitting—Care of Metal

Shops that do a large amount of babbitting generally have their babbitting pots equipped with pyrometers for determining the temperature and with automatic temperature regulators which keep the temperature within the allowable limits. Where these instruments are not available, the temperature can be judged by immersing a pine stick in the molten bath and observing its appearance. The right temperature both for tin-base and lead-base babbitts is obtained when the stick chars rapidly without burning. If the stick chars slowly, the temperature is too low, and should the stick catch fire it is an indication of a too high temperature.

Tin-base babbitts are less sensitive to the influence of temperature than are lead-base babbitts. Though the best results are obtained when the babbitt is maintained at a temperature between 750 and 890 deg. F., reasonably good linings can be obtained with tin-base babbitts even if the temperature is somewhat higher or lower. A higher temperature is to be preferred, since a low temperature is likely to result in the babbitt shrinking away from the shell.

Lead-base babbitts are sensitive to temperature changes, their properties being considerably impaired by incorrect babbitting practice. This is clearly shown by Fig. 3, which gives the result of hammer tests carried out on specimens of lead-base babbitt, poured at different temperatures. Whether poured at a temperature too high or too low, the resistance of the babbitt against hammer blows is considerably decreased, resulting in the babbitt flattening out and cracking with comparative rapidity.

Babbitt metal should be stirred thoroughly from the bottom of the pot at frequent intervals when being used to prevent segregation of the constituents. If the pot is used only occasionally, the babbitt should be covered with sawdust to prevent the formation of dross.

Babbitting—Pouring

Bearings should ordinarily be poured in a vertical position unless the irreguar shape of the bearing makes this position inadvisable. In such cases the bearing should be inclined at the most suitable angle and the babbitt be poured at the most convenient point. In pouring a split bearing at an angle, the parting face should be on the under side, resting on the jig. Babbitt metal should be poured from a self-skimming ladle, if available, in a steady, slow stream directly along the mandrel. If poured too fast or intermittently, blowholes and air-pockets will be formed, which naturally is of disadvantage since it means added work.

Small blow-holes, if few in number, should be filled in with the babbitt metal by the use of a hot soldering iron. If blow-holes are large in size or number, or if seams have formed, the lining should be melted out and the bearing rebabbitted. The excess babbitt from the windows should be removed with a hot soldering iron.

Importance of Tinning Shells Previous to Babbitting

The importance of tinning shells previous to babbitting is borne out by the following test which duplicated the vibration and pounding of the armature of an electric motor. This test produced a pounding action, delivering successive blows on the babbitt lining in the body of the bearing shell. These blows were recorded by the revolutions on a counter, and the results of the test were as follows:

Shell untinned, lead-base lining	40,000 revolutions
Shell untinned, tin-base lining	200,000 revolutions
Shell tinned, lead-base lining	800,000 revolutions
Shell tinned, tin-base lining	2,000,000 revolutions

Service Results

Correct babbitting practice results not only in decreased wear and prolonged life of the babbitt lining, but also in reduced friction losses and higher efficiency of the machine. In many cases where complaints had been made about the short life of babbitt linings of industrial motors, it was at first thought that the failures were due to the quality of the babbitts employed. Investigations, however, showed that poor babbitting practice was solely responsible, and by correcting the babbitting practice, linings were obtained which were satisfactory. It has also been found that babbitt linings of railway motors, made according to the practice outlined herein, lasted from three to four times as long as was previously considered the average life of the linings.

BABBITTING TIPS

Lead-base babbitts cost much less per pound, but weigh 40 per cent more than tin-base babbitts.

* * * *

Bronze shells should be tinned and preheated.

* * * *

Mandrels and iron shells should be preheated to the melting point of the alloy.

* * * *

Check babbitt temperatures carefully before pouring the metal.

ACCURATE SAMPLING
from Unit Pulverizers

By P. A. Willis
Assistant Professor, M.E.,
School of Mines and Metallurgy, University of Missouri

IN ORDER to keep a check on the performance of a pulverizer, it is necessary to obtain frequent samples of the pulverized coal to test for fineness and moisture. This is not difficult in connection with the storage system, but with a unit pulverizer it is usually no easy matter to secure a sample that represents the average product of the pulverizer.

The sample can best be obtained by withdrawing it from the duct leading from the pulverizer to the burners,

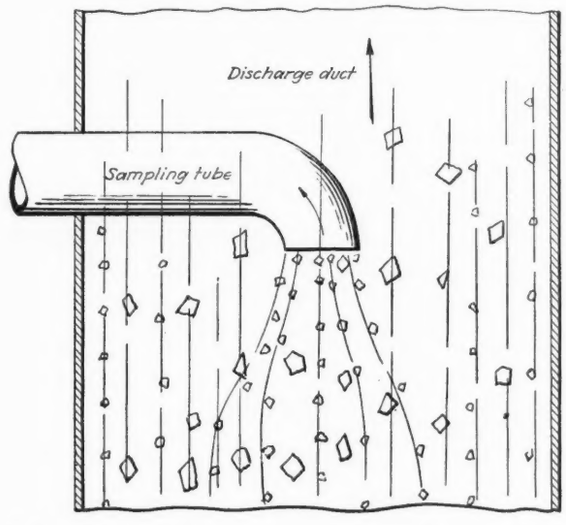


Fig. 1—Too much suction on the sampling tube will cause the sample to be too fine

and the most convenient location is usually a few feet above the pulverizer fan. However, the air velocity is likely to vary widely over the cross-section of the duct, and this causes a variation in the quantity as well as in the relative fineness of the coal as sampled from point to point.

To make a complete traverse of the entire cross-section of the duct with a sampling tube is rather laborious, especially when there are a number of pulverizers and daily tests are to be made upon each. Furthermore, the velocity of the air and coal entering the mouth of the sampling tube must be the same as the velocity in the duct at that particular point, otherwise the fineness of the sample will be considerably in error. This error arises from the fact that the finer particles of coal are more easily deviated from their course than the larger, heavier particles. Thus, if the velocitiy of flow at the entrance to the sampling tube is greater than the velocity in the duct at that point, the sample will be too fine, while a lower velocity at the mouth of the sampling tube than in the duct will result in a sample that is too coarse. The two conditions are illustrated in Figs. 1 and 2.

In actual tests the writer has found that the percentage of particles that will pass through a 200-mesh sieve may be made to vary as much as 100 per cent by merely varying the suction on the sampling tube. In the following paragraphs an arrangement will be described by which accurately representative samples may be taken.

In an installation consisting of six unit pulverizers having a capacity of 15,000 lb. per hour each, it was desired to devise a standard method of sampling in order to obtain reasonably accurate daily samples from each of the machines. The following method was pursued and should be applicable with slight modifications to almost any unit pulverized installation.

It was decided that the best location for obtaining the sample was in the discharge duct about four feet above the shaft center. The duct at this point was rectangular in cross-section, its inside dimensions being 18x23 in. It was also decided that the most convenient means of

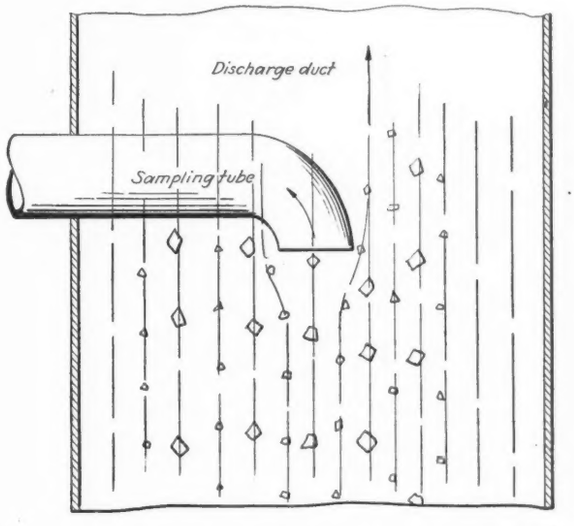


Fig. 2—Insufficient suction will produce a sample that is too coarse

withdrawing and collecting the sample was an ordinary vacuum cleaner and dust collecting bag. A $\frac{1}{2}$-in. pipe of the proper length with an ell on the end was used as the sampling tube. A special fitting into which the pipe could be screwed was made up and attached to the suction side of the vacuum cleaner. The arrangement of the entire apparatus is shown in Fig. 3.

It was then necessary to determine at what point in the duct this tube should be introduced. The duct cross-

section was divided into twelve areas 6x5¾ in. each, and samples were taken at the center of each area, as shown in Fig. 4. To do this, three holes were drilled in the end wall of the duct and tapped to 1¼-in. pipe size. They were so located that four samples could be taken through each hole. A special bushing was made up to screw into these holes and support the entire sampling device. The

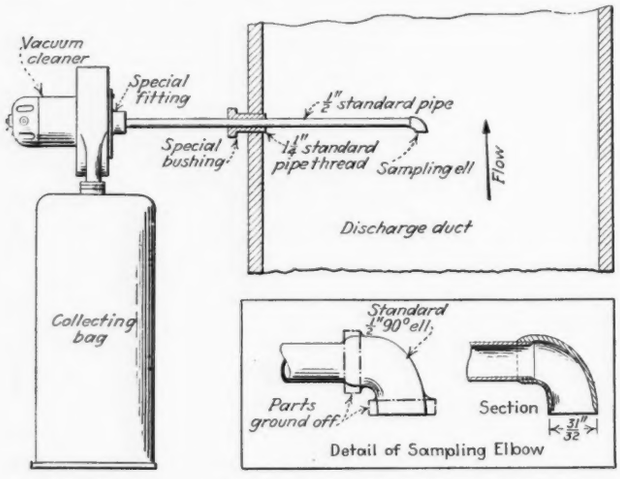


Fig. 3—Arrangement of pulverized coal sampling device. Insert—Detail of sampling ell used

hole through this bushing was drilled and reamed to the proper size to allow the sampling pipe to slide through freely without undue leakage of coal. The bushing of course was slipped over the sampling pipe before the pipe was screwed to the vacuum cleaner. The ½-in. ell on the end of the pipe was ground down as shown in the insert, Fig. 3. This was done to permit its entrance through the holes in the duct wall as well as to present a smaller projected area to the flow of coal and air within the duct.

The next step was to determine the size of opening of the mouth of the sampling ell that would produce a velocity at that point equal to the average velocity in the duct. It was impossible with the means at hand to make a direct determination of the velocity either in the duct or in the sampling ell. A pitot tube inserted in the duct immediately became clogged with coal and no reliable reading could be obtained. It was then found that the problem could be solved by comparing the amount of coal passing up through the duct with that entering the mouth of the ell, over a unit area per minute.

As it was possible to weigh the coal entering the pulverizer, it was a simple matter to determine the amount of coal passing up the duct as long as the pulverizer was operating at a constant rating. Using the sampling apparatus, a composite sample was obtained by withdrawing coal from each of the twelve locations in the duct, over a period of twelve minutes, or one minute at each point. The total coal collected was weighed and the quantity entering the mouth of the ell per square inch per minute was calculated. After several trials it was found that an inside diameter of the mouth of the ell of $\frac{31}{32}$ in. would allow the sampler to withdraw the same amount of coal per unit area per unit time as passed through the discharge duct.

It now remained to find a point in the duct from which a sample could be withdrawn that would be equivalent in fineness to that of the composite sample previously obtained. Separate samples were now taken at each of the twelve points and a screen test run on each sample. "Contour lines" were then drawn through points of equal fineness over a plan of the duct cross-section. It was found that a point on the center line of the duct 7½ in. from one end wall would produce the true average sample desired. The sampling pipe was then shortened so that when inserted through the bushing as far as possible, the ell was at the proper point to secure the average sample.

The apparatus is now in daily use taking samples from each of the six pulverizers. About five minutes is required to obtain a large enough sample for the necessary screen and moisture tests.

It has been found that a variation in rating will result in an incorrect sample. This is due to the change in velocity in the duct which must necessarily accompany the change in rate of output. The sampling tube will then be incorrectly designed for the new condition. In the installation mentioned, the boilers are operated at a fairly constant rating and the sampling device has been designed to give a true sample at this normal rating. If the boilers were operating under an extremely varying load, it would be necessary to take samples only when the pulverizers were operating at the rate of output for which the sampling apparatus was designed.

When a unit pulverizer is in good condition and is being properly operated, there is little variation in the size of

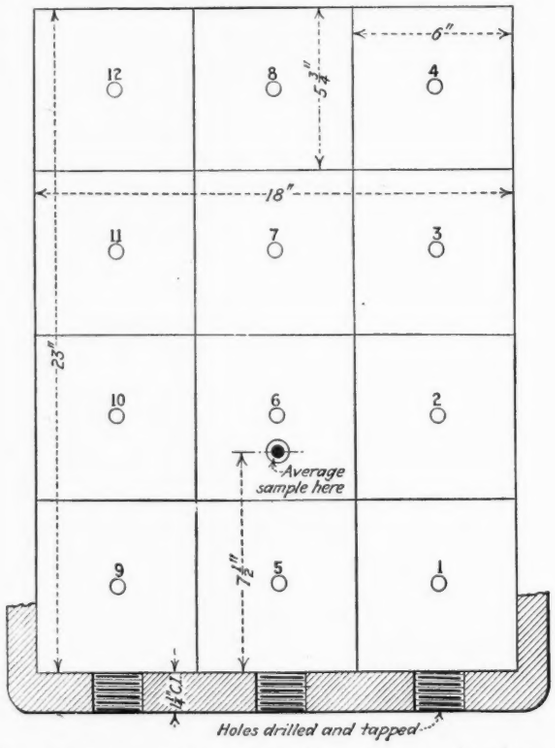


Fig. 4—Cross-section of discharge duct, showing the twelve sampling points and the point at which the average sample was obtained

the particles of the pulverized coal, all the coal being comparatively fine. Under these conditions the errors in sampling due to incorrect velocity or improper location in the duct have but a slight effect upon the accuracy of the sample. But after the pulverizer has become worn, there is a much greater variation in the size of the particles and all the errors in sampling are greatly magnified. Thus it is much easier to obtain a true sample when the pulverizer is in good condition immediately after overhauling than it is after the pulverized parts have become worn and the machine is producing coarse coal.

Doing Your Best with Existing Equipment

By L. W. Hayward
Combustion Engineering Corporation

HOW does the manager know that the engineer is obtaining the best possible boiler and furnace efficiency with the equipment in his plant? He usually knows the monthly cost of fuel and the capacity at which the factory is operating and can compare these figures with those obtained in previous months. If the coal consumption is high, he knows that either too much heat or power is being used per unit of product or that the power plant is burning too much coal to produce a pound of steam. In the latter case the engineer is immediately called on the carpet. But what if the coal bill compares favorably with the previous coal bills or is less? Is the engineer told that he is spending too much money for coal?

Public-utility and large industrial plants usually have trained engineers who, by the aid of instruments and metering equipment, analyze the cost of power production and are able to tell where the losses occur and the best way to reduce them with the equipment available.

Analyzing Costs

The smaller industrial plants, of which there are a large number and which consume a large percentage of the coal mined, are not usually equipped to analyze these wastes. The manager may know the cost of coal per unit of product, but does he know whether this cost is the lowest possible with the personnel and equipment which he has? When the engineer is approached on this subject, he feels it is an opportune time to present his side of the matter and usually asks for more modern equipment, to bring the plant up to date. He also finds it an opportune time to ask for a better grade of coal and better metering and control equipment to aid in telling what results are being obtained.

The engineer probably is right when he asks for such improvements, but there is still the question of whether he is obtaining the best efficiency possible with the coal and equipment he now has. Unless he is obtaining the best efficiency possible, he should not expect the management to purchase additional apparatus.

To satisfy himself, the manager often calls in a combustion engineer to analyze the boiler-room operations and to make suggestions as to how to improve efficiency. Large fuel-burning equipment manufacturers usually have such men available to send to their customers upon request. Such a procedure not only convinces the manager as to the desirability of having such an analysis made at frequent intervals, but helps the engineer to improve his operating conditions.

In the every-day contact with equipment one naturally takes for granted that the equipment is operating right, as it is the way it has been continually operating in the past. It often takes someone not acquainted with the ordinary routine of operation to point out where improvements are possible. A few of the troubles the writer has discovered in the last year will show some of the things that can happen.

In a paper plant with three natural-draft traveling-grate stokers, burning Indiana coal, the fuel bill was extremely high owing to the large amount of coke lost in the ashes. The stack had not been of sufficient height to give the best results, and stokers with a large area of grate surface per square foot of boiler surface had been installed. Upon analyzing the operation, it was found that the coal was not wet down before feeding it to the hopper. By properly tempering the coal as it was delivered to the boiler room, we were able to reduce the ashpit loss to such an extent that they could easily carry the plant load on one boiler where, previously, it had required two boilers, and the plant manager later reported they were saving 30 per cent of their coal bill.

Another plant with two natural-draft traveling-grate stokers using Illinois coal, was burning an excess quantity of fuel, although the load was extremely light. The engineer did not realize the enormous loss that could occur by leaving the stack damper wide open with only a short fire on the grate. By closing the damper the proper amount and regulating it according to the load, the CO_2 was raised from 3.5 to 10 per cent and the stack temperature reduced over 125 deg., which resulted in a 50 per cent saving in fuel.

Experiences in One Plant

In a plant equipped with eight natural-draft traveling-grate stokers, they were having difficulty with excessive maintenance on the stokers under the four larger boilers and also trouble carrying the desired load. It was found that a common water flume for continuous ash removal was designed with no air seals between the pits of the various stokers. The furnaces with the highest draft were pulling the hot gases from the furnace with the lowest draft over the rear end of the stokers, into the common ash flume, and up over the rear end of the other stokers into the high-draft furnaces. These hot gases passing over the rear of the stoker grates naturally caused high maintenance.

A plant equipped with two underfeed stokers installed under modern settings, was having trouble due to smoke. A good grade of West Virginia coal, low in ash and high in volatile, was being used. It was found impossible to eliminate this smoke with the $2\frac{1}{2}$-in. screenings they were burning, but by using $1\frac{1}{4}$-in. screenings from the same mine, the smoke nuisance was entirely eliminated.

Another underfeed stoker plant could not carry the load without continually barring the fires. It was found that the forced-draft fan blades had become covered with dirt to such an extent that the fan, when operating at maximum speed, could not deliver enough air at the required pressure to overcome the resistance of the fuel bed unless the fuel bed was continually broken up. Not far from this station was another plant with similar

equipment and similar troubles, and upon making an examination it was found that the forced-draft fan, which was of the double-rotor type, had been installed with each of the two rotors placed end for end on the fan shaft, so that the center portions of the rotors were on the outside, thus practically shutting off the air inlets to the fan. This plant had been operating for over a year under these conditions.

It would be possible to go on naming other conditions and combinations of these conditions that are continually being found, but you will say that these are all obvious troubles that should be easily found and should not exist. It is usually the simple things that slip by us and give the most trouble.

No mention has been made of the losses due to air infiltration through defective air seals, leaky settings, doors that do not close up tight or that are left open, dampers that are thought to be closed and dampers that are never operated. These are also obvious, but there are many plants that could reduce their coal bills if the engineers realized what these obvious things mean to them.

To check these wastes, ask yourself what the equipment is designed to do and where the heat in the coal goes that is not used in producing steam; then set out to recover all these waste heat units possible with the equipment you have.

Lubricating Worm Gears

By W. E. Warner

SOME interesting experiments were carried out by the British National Physical Laboratory to determine the efficiency of worm-gear lubricants. The addition of a small amount of fixed oil (non-drying vegetable oil) to ordinary mineral oil was found to be beneficial. It raised the critical temperature of the mineral oil, above which temperature the lubricating efficiency of mineral oils rapidly decreases. Adding 2.5 per cent of fixed oil to 97.5 per cent mineral oil was found to give good results, the critical temperature being raised about 20 degrees.

Adding larger amounts of fixed oils did not seem to have any material effect on either the critical temperature or the lubricating properties. The critical temperature of an oil is the temperature at which it begins to break down and lose its lubricating properties, and above which it is not safe to use it as a lubricant.

The type and character of the fixed oil added did not seem to have a marked effect. Adding different fixed oils to the same mineral oil gave similar results. Graphite additions were also made to mineral oils and were found to have much the same effect as fixed oils. The critical temperature was raised, but all oils did not respond to this treatment as well as they did to the addition of fixed oils.

The character of the graphite added has a marked effect. Ordinary graphite may contain abrasive impurities, and it is important that for this work any impurities that the graphite may contain are non-abrasive. It should be very finely powdered and about one to one-and-one-half per cent graphite should be added to the oil. Where flake graphite has been used, there has sometimes been increased wear on the worm and trouble with clogging of oil passages. These troubles can be avoided by using graphite of high purity and only such a quantity as will remain in suspension in the oil.

Putting Old Rope Into Service

By M. R. Sumner
General Superintendent of Construction,
Byllesby Engineering & Management Corporation

WITH any power-plant construction department there is always the problem of what to do with rope tackle after it has become a little old. On account of the large volume of construction work handled for the Philadelphia Company and its affiliated operating companies by our Pittsburgh branch in 1927, we found ourselves at the beginning of this year with a large supply of rope on hand, varying as to size and condition. Nearly all this rope had been used one or more times and much of it was soiled with grease and mud. As there is but little salvage value in second-hand rope and as we are constantly using rope in our work, the problem was to make the best use of the rope without jeopardizing the lives of our workmen. The method of testing each piece and marking it with a tag recording the test data was developed by the organization.

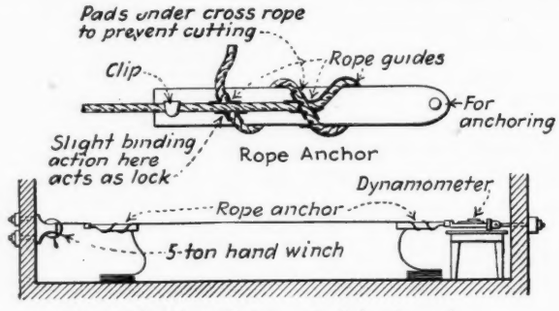

Pads under cross rope to prevent cutting
Clip
Rope guides
For anchoring
Slight binding action here acts as lock
Rope Anchor
Dynamometer
Rope anchor
5-ton hand winch
Rope Testing Set Up - Safety Guard Screens at Both Ends not Shown

Fig. 1—Rope anchor and rope testing set-up

The illustration shows a rope anchor, developed to hold an "endless" rope without any cutting action. The anchoring action is practically all due to snubbing. The "lock" binds the turns effectively. All bends are so designed that the radius is the same as that of a sheave for that size rope.

Anchor Diameter for Different Sizes of Rope

$\frac{3}{8}$ in. and $\frac{1}{2}$ in. rope—	$2\frac{1}{4}$ in. diameter pipe
$\frac{5}{8}$ in. and $\frac{3}{4}$ in. rope—	$3\frac{1}{2}$ in. diameter pipe
$\frac{7}{8}$ in. and 1 in. rope—	$5\frac{1}{2}$ in. diameter pipe
$1\frac{1}{8}$ in. to $1\frac{3}{8}$ in. rope—	8 in. diameter pipe

Two operators are needed in making the tests. One man operates the winch, while the other reads the dynamometer. The test value marked on the test report which is attached to the rope is placed $33\frac{1}{3}$ per cent lower than the actual results obtained to provide a factor of safety.

No Data Available

Our first thought was to turn to various handbooks and other published data for information relative to the loading that might safely be applied to various sizes and kinds of rope. We were unable to find uniform or reliable data, and therefore it appeared necessary to develop original information to meet our requirements.

Since almost all this rope was used in blocks, it was necessary to know the forces that would be at work when the ropes were so used. Two tests were made to determine these values. In the first a set of steel blocks having a $1\frac{1}{2}$-in. sheave was used, while in the second we used a set of 3-in. wooden blocks. In the testing layout the load end and the dead end of the rope were anchored to dynamometers and a fall line pull of 500 lb. was applied. By varying the number of sheaves, the relations between the load and the dead-end pulls to the fall-line pull could be established, as shown in Fig. 2. Only one size of rope was tested, namely, $\frac{1}{2}$-in. It is assumed that the same percentage of friction loss would

occur in other sizes. We have found that the cost of making these tests, based on the methods herein described averages about 2.5 per cent of the value of the rope tested.

This information gave a foundation for the actual testing of the ropes and is printed on the reverse side of the rope-testing tags, a sample of which is shown in Fig. 3. One of these tags, with the testing data filled in with ink, is attached to each length of rope after it is tested. This tag informs the foreman who receives the rope on a job, that it has been tested, and the safe loading he can put on it without danger to employees or equipment. The relation of the "marked" maximum piece to the testing strain for manilla rope is shown in the table.

ROPE TESTING STANDARD MANILLA ROPE

Strain Table

Size In.	Tested Strain Lb.	To Be Marked Lb.
¼	275	135
⅜	540	270
½	1,000	500
⅝	1,560	780
¾	2,240	1,120
⅞	3,060	1,530
1	4,000	2,000
1⅛	5,120	2,560
1¼	6,240	3,120
1⅜	7,620	3,810
1½	9,000	4,500
1¾	12,240	6,120
2	16,000	8,000

The rope anchor shown in Fig. 1 is an original development which has been devised so that the position of

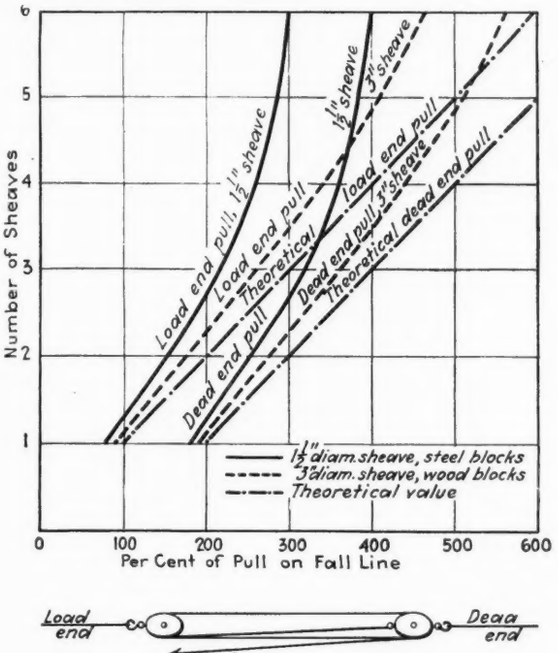
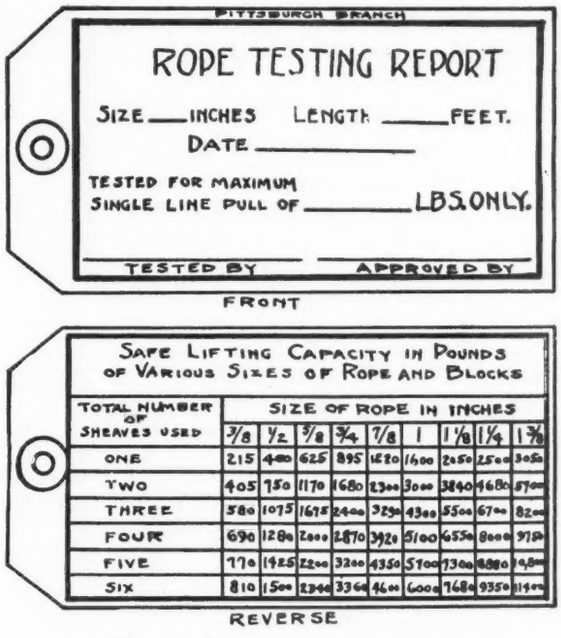

Number of Sheaves
Per Cent of Pull on Fall Line
Load end pull, 1½ sheave
Load end pull, 1" sheave
Theoretical
Dead end pull
1½" sheave
3" sheave
Load end pull
Dead end pull 3" sheave
Theoretical dead end pull
1" 1½ diam. sheave, steel blocks
3" diam. sheave, wood blocks
Theoretical value
Load end
Dead end
Fall line
Test conditions: 1" rope
500 lb. pull on fall line in all cases
Blocks in same condition as in field

Fig. 2—Results of rope tests

the rope at the anchor end and also at the dynamometer end would be the same as if the rope were operating in a rope block. These rope anchors have been made in several different sizes by a steel fabricating shop in Pittsburgh.

We have found that the cost of making these tests averages about 2½ per cent of the value of the rope tested.

The plan is entirely successful in operation and provides another means of reducing operating costs. As the rope is tested along its entire length, the workman has a sense of security, when handling the rope with a lifting job, far beyond that experienced when he knows that only a sample has been submitted to test. An interesting feature brought out by the tests is shown in Fig. 2. The actual dead-end pull with any given


PITTSBURGH BRANCH

ROPE TESTING REPORT

SIZE ___ INCHES LENGTH ___ FEET.

DATE ___

TESTED FOR MAXIMUM SINGLE LINE PULL OF ___ LBS. ONLY.

TESTED BY ___ APPROVED BY ___

FRONT

SAFE LIFTING CAPACITY IN POUNDS OF VARIOUS SIZES OF ROPE AND BLOCKS

TOTAL NUMBER OF SHEAVES USED	SIZE OF ROPE IN INCHES								
	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1⅜
ONE	215	400	625	895	1220	1600	2050	2500	3050
TWO	405	750	1170	1680	2300	3000	3840	4680	5700
THREE	580	1075	1675	2400	3250	4300	5500	6700	8200
FOUR	690	1280	2000	2870	3920	5100	6550	8000	9750
FIVE	770	1425	2200	3200	4350	5700	7300	8880	10800
SIX	810	1500	2340	3360	4600	6000	7680	9350	11400

REVERSE

Fig. 3—Rope testing report card

The sketch shows the card which is attached to each rope after it is tested. Both testers sign the card. A table of safe lifting capacities for blocks is on the reverse side of the card. These values were obtained by multiplying the per cent of pull on fall line load end, from Fig. 2, by the allowable strain given in the table.

number of sheaves varies with the size of the sheaves. For example, with 100 lb. on the fall end, six 3-in. sheaves give approximately 560 lb. on the dead end, but only 400 lb. in case of 1½-in. sheaves.

Warships Will Use Diesels

FOREIGN governments plan to use Diesels for cruising power in turbine-driven warships, according to statements made by Julius Kuttner before the Oil and Gas Power Sessions at the recent A.S.M.E. meeting in New York. Although official confirmation was lacking, Mr. Kuttner said that the British mine layer "Adventure," with 40,000 s.hp. in steam turbines was to be fitted with Diesel engines for operation at cruising speed. The same applied to the 65,000-s.hp. "Konigsburg," of the German navy. The advantage of using Diesel engines for this purpose was recognized many years ago, but the present year gave the first indication of any real activity in this direction.

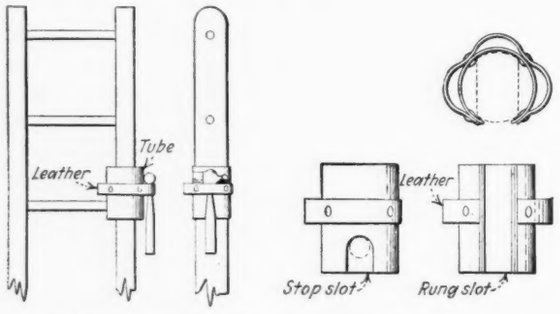
In the application of double-acting Diesel engines to marine propulsion the most noteworthy innovation in Mr. Kuttner's opinion was the use of speed-reducing gears between the engine couplings and the propeller shafts. The 16,000-ton twin-screw passenger motorships "Milwaukee" and "St. Louis," under construction in a German shipyard, were being fitted with four double-acting two-stroke-cycle M.A.N. Diesel engines of approximately 3,200 hp. by means of gearing, the normal speed of the motors being 215 r.p.m. Because of their high speed the engines alone weighed only 600 metric tons per vessel and space requirements were greatly reduced.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

Adjustable Ladder Toolholder

THE drawing shows a handy toolholder for use when making minor repairs or adjustments while standing on a ladder. Having some of this work to do, I found that the various tools, such as hammer, wrench, screwdriver, etc., could not be conveniently carried in my pockets, so I devised the toolholder shown, which is so



Holder slides on ladder and hooks over rung

made that it can be slid up and down the ladder and locked on any rung.

The holder is made from a piece of tubing large enough to slide on one side of the ladder. It is cut out so that it will slide over the rungs, and another slot is made to lock it in the position needed. Around the tube a piece of leather strap or belting is riveted in loops, so that tools can be slipped in and held while the work progresses.

H. Moore.

Hamilton, Ont., Canada.

Substituting High-Pressure Gas for Steam Saves Buying New Blower

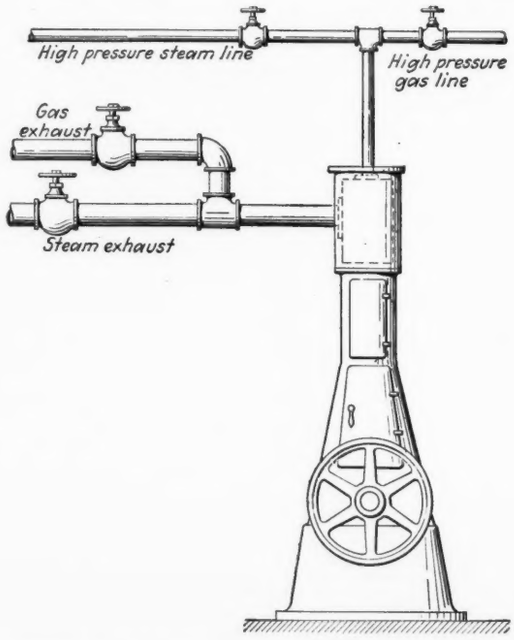
IN THE work of building up plant efficiency the engineer must not only make a systematic study of each piece of apparatus separately, but must cultivate a broad and comprehensive view of the plant as a whole. He will thus be enabled to so co-ordinate the various operations and processes as to secure the most economical use of fuel, power, water, etc.

Often he will find that money invested in new equipment would soon be repaid, but before the purchase is made he should determine just what might be done by revamping old machines. Or sometimes it may be possible to adapt an old machine to a use altogether different from the one for which it was originally intended, and when this can be done at no great sacrifice in efficiency, it is sound practice.

I might mention in this connection a hook-up that we recently worked out. There is nothing fundamentally new or startling in this arrangment, and many readers of *Power* have doubtless done something of the kind. I merely cite it here as being of probable interest to many and of possible value to some. At any rate it saved us the cost of a motor-driven blower and permitted us to utilize fully our present equipment.

Our gas plant supplies a town of 20,000 population with carbureted water gas. Each of the two gas generators is equipped with a waste-heat boiler, and when both machines were being operated in parallel, sufficient steam was produced to drive the blower and supply the generators. But in the warmer months, when only one generator was in operation, the steam produced was insufficient for these purposes, and the deficiency was supplied from the boiler room of the electric plant a short distance away.

As the extra amount of steam required was not great, it was not a serious item so long as the boilers had to be kept on the line anyway; but when the boilers came to be used for stand-by duty only, the thing that prevented them from being banked for hours at a time was the necessity of supplying that small amount of steam to the gas plant. We found that the extra cost of keeping a small fire in one of the boilers during the hours that the gas plant operated was approximately $15



Arrangement of steam and gas connections to engine

per day. It was evident, therefore, that a motor-driven blower in the gas plant would be a good investment, as it would eliminate the need of the extra steam and permit the boilers to be put on bank.

Before purchasing the new blower, however, we cast about to see what could be done with the existing equipment. Now we normally store about 100,000 cu.ft. of gas at a pressure of 100 lb. gage. We use a motor-driven compressor to handle it, and since this compressor is of sufficient capacity to take care of our maximum output with two machines in operation, it is only partly loaded

when only one gas machine is being used. And since the storage pressure is almost as high as the normal steam pressure on the waste-heat boilers, we figured that one of the steam-driven blowers could be run on the high-pressure gas, exhausting back into the compressor suction.

It was only a small job to arrange one of the blower engines for either steam or gas drive, as shown in the illustration. We found that the operation on gas pressure was just as satisfactory as on steam, and that the additional load imposed on the gas compressor amounted to only a few kilowatts. M. F. KNOY.

Lake Charles, La.

Bronze-Welding Bearings for an Oil Engine

SHORTLY after the bearings of an oil engine had become so worn that they were almost useless, an accident occurred which broke both bronze main bearings. Naturally, the fracture occurred where the metal was thinnest—at the bottom of the bearing and at the top where shims had been used between the back surface of the bearing and the bearing supports. After the four broken parts had been removed, there was some question as to whether it would be worth while to repair the bearing. A welding operator was asked his opinion and stated that if a surface of bronze was laid down on the outside of the bearings, there would be ample room for machining and fitting a new inner surface and new oil grooves.

A chipping hammer was used to make a vee on the broken edges. Then with bronze rod the welder joined the two broken parts and bronze-welded the vee on the inner surface, as shown in Fig. 3. The half of the bearing was then turned over and the vee welded on the other side.

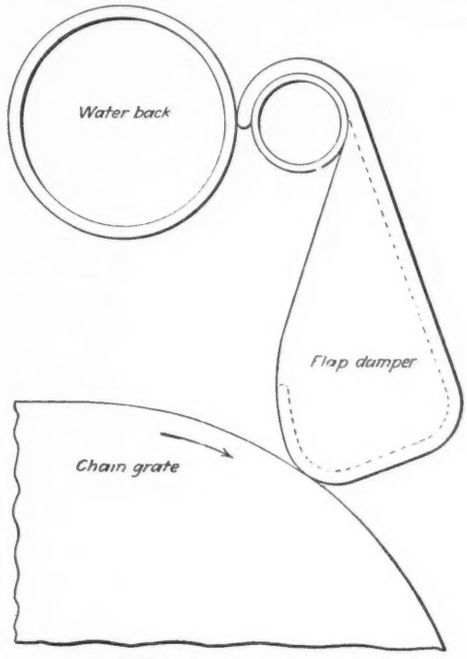
After this had been finished, the outside of the bearing was built up with bronze weld metal to a thickness of about one-quarter inch, as in Fig. 1. This was then machined level. A similar thickness of metal was welded on the outside of the other half of the bearing. The two halves were put into the base again and the shaft fitted to them.

This method of repair is far cheaper than the replacement of the bearing. After the part was placed back into service it worked as satisfactorily as before.

New York City. JOHN GOOD.

Stopping the Air Leakage Past the Chain Grate with Flap Dampers

THE illustration shows a type of cast flap damper we made to prevent air leakage past the rear end of our chain-grate stokers. These dampers are four inches wide and were suspended from the return line from the water-backs. The lower end of the dampers rested against the grate as shown. The dampers are made



Arrangement of flap dampers at rear of chain grate

with webs on their sides to permit them to swing past each other without producing an opening. This construction allows any damper to open as much or as little as necessary to pass whatever the grate brings to it without affecting the other dampers. The object of the web was to keep the air shut off and to prevent distortion.

The first dampers put on were turned with the pocket from the fire. They held their shape, but holes burned through the back of them quickly. On the next set the pockets were turned toward the fire. These filled with ashes and protected the dampers. W. L. PARKER.

Elgin, Ill.

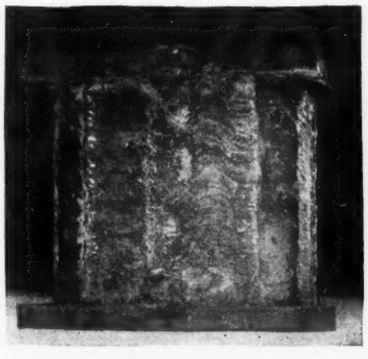


Fig. 1—Welding a layer on the bearing back

Fig. 2—The broken bearing before welding

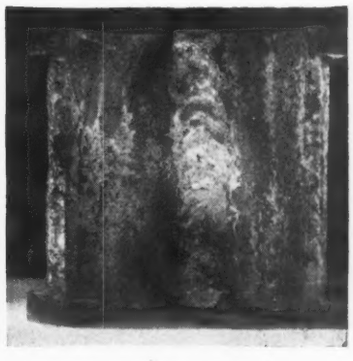


Fig. 3—Welding the inner side of bearing

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Low-Temperature Carbonization Plant at Dunston

IN REFERENCE to the report of the London Fuel Conference contained in your issue of Oct. 30, we would like to call attention to the description on page 723 of the low-temperature plant at Dunston and to amplify one or two of the statements.

As stated, the Dunston plant operates in conjunction with the Newcastle-on-Tyne Electric Supply Company, Ltd., power station at that place, but it may interest your readers to know that we have acquired the patent rights for the process, which is now known as the Babcock process, and are actively engaged upon its commercial development in connection with the steam-raising plant.

As to the statement that the plant at Dunston produces only low-temperature oils, we should like to point out that, apart from the low-temperature coke and gas supplied to the boiler furnaces, this plant is actually producing and has for several years been making, byproducts, motor spirit, crude paraffin, pitch, white spirit creosote, and crude cresylic. These byproducts are the result of pretreating the Northumberland coal normally used in the power station, and all of them have been sold at prevailing market prices.

Also, referring to the fixed charges on the Dunston plant, it should be pointed out that these have not been taken into account in the figures quoted because the installation is on a relatively small scale. It is not installed as part of a boiler house which forms an integral part of a power station, and therefore the cost of supervision and other charges are higher than would be the case in actual practice. Further, the cost of installing what was, in the first instance, an experimental plant, should not be taken as a basis on which to establish the return which we are confident can be expected from the large-scale plant we propose putting forward.

London, England. E. SMYTHE,
Babcock & Wilcox, Ltd.

* * * *

Position of the Marine Steam Engine

THE article on page 749 of the Nov. 6 issue of *Power* under the title, "The Steam Engine's Position in the Marine Field," is misleading in many respects.

The article begins: "If it is asked whether to any degree motor tonnage has taken the place of steam tonnage, the answer must be in the negative, for what has actually happened is that both have gained at the expense of sail tonnage."

The conclusion is then drawn at the end of the article as follows: "Steam tonnage has therefore not lost by reason of the advent of the Diesel engine except so far as the Diesel has taken the percentage of sail tonnage that would otherwise have been replaced by steam."

The life of a ship is normally taken at from twenty to twenty-five years. Ships of the world as of July, 1928, totaled 65 million gross tons. It has only been about five years since the motorship began to make serious inroads into the domain of the steamer, therefore the extent to which the motorship is replacing steam is properly determined by considering the percentage of new ships that are being built as motorships rather than by comparing the tonnage of new motorships with the total tonnage of world shipping, much of which was built before the first motorship was launched.

Lloyd's Register of Ship Building Returns for the quarter ended Sept. 30, 1928, reports the type, number and horsepower of marine engines under construction in the world. There were 249 reciprocating steam engines totaling 414,001 hp.; 33 steam turbines, excluding turbine engines building in Germany, of 345,500 hp., and 364 oil engines totaling 1,281,178 horsepower.

The percentages of motor to total tonnage under construction throughout the world has shown steady progress during the last five years as is disclosed by the tabulation.

Year	1923	1924	1925	1926	1927	1928
Per cent	19	28	42	47	51	56

In other words, the ratio of motor to steam tonnage under construction throughout the world has risen from 0.22 to 1.3, and each year has shown a steady increase.

EDWARD B. POLLISTER, Gen. Manager,
Busch Sulzer Diesel Engine Company.
St. Louis, Mo.

* * * *

Why Scrape a Bearing to Fit?

THE letter by W. G. Forbes in the Nov. 14 issue takes me back a good many years to the time I was serving as a machinist apprentice in a railroad shop. Machine tools in many cases had outlived their usefulness. The driving-wheel lathe, in particular, was a weak sister, not only in power but in accuracy, particularly when it came to turning driving-axle journals. In fact, the journal was just about as bad after it had been turned as it was before.

The result was that most journals were not turned, and as they were usually elliptical when the engine came into the shop for repairs, the fitting of the driving boxes was not particularly easy.

The practice was to bore the box to the smallest size of the journal, and then the machinist used a square bastard file until he got the shell loose enough on the journal so that it would rotate on it freely. The filing was done first on the sides of the shell, and continued until the crown of the brass showed a bearing. After this a scraper was used to remove the roughness left by the file, and when the gang boss thought that the bearing was about right, the job was supposed to be finished.

Years afterward it became the practice in shops with which I was connected, to do all the fitting with a square bastard file even on new journals, and it was a rare thing when this practice was followed — getting, of course, a reasonable bearing—to have any difficulty with warm journals.

I remember one instance in which a passenger engine had to be wheeled in an emergency, that had no tryout before it went on a fast run, whose boxes were fitted in this way. There is a story connected with this that might be told some other time, but the point is that no trouble was experienced on its first run.

I strongly believe that for most purposes it is not necessary to go to the expense of scraping the bearing. If it is properly designed, the journal rests on the oil film, and the more easily this film can be carried around with the journal, the better the oiling will be. The file marks leave channels through which the oil can readily pass.

Another illustration that may not occur to the average reader of *Power* is the ordinary railroad car brass. These brasses are not and cannot be fitted to the journal. A new brass always has a slightly greater radius than a new journal has, and the same brass is applied to a worn journal which may be $\frac{1}{4}$-in. smaller in diameter than a new one. The lead or composition lining of the brass fits itself to the journal in a few revolutions far enough so that the oil film begins to operate.

I do not think it is beyond reason to believe that in many cases a babbitt-lined bearing requires no fitting.

Of course I would not say that the foregoing methods are proper to use in all cases, but I would point out that much unnecessary fitting of bearings is done and that just as good results, and even better, may be expected from methods that at first thought seem to be crude and unmechanical. We are all trying to save time and money, and if this can be done without detriment to operation, certainly more expensive methods should be avoided.

Hollis, N. Y. S. W. MILLER.

* * * *

Probable Causes of Explosions in Diesel Engines

OCCASIONALLY, there have been cases of explosions occurring in the crankcases of Diesel engines and in a few instances members of the operating staff have been injured by the flying fragments of inspection doors or sections of the crankcase frame.

Fortunately, explosions of this sort are few and far between, nevertheless they do occur and are not confined to any particular type of engine. In some cases the cause has never been explained satisfactorily. The following reasons are advanced with the idea that they may serve a useful purpose in the prevention of explosions and perhaps assist in the diagnosis of the cause leading up to any operating difficulty encountered along these lines.

To begin with, let us examine the small Diesel engine, which is not equipped with an oil- or water-cooled piston head. In order to prevent the oil mist or fog, which is present in the crankcase, from coming in contact with the piston head, small engines are now universally equipped with an oil shield plate located two or three inches below the top inside area of the piston. In other words, an air space is left between the hottest part of the piston and the plate. Hence the oil spray in the crankcase cannot come in contact with the top of the piston, but comes in contact with the plate, which is cooler.

Unless these plates are maintained in a pressure-tight condition, they are a possible source of danger in the operation of the engine. For example, suppose the oil mist in the crankcase is able to find its way into the air space above the plate when the engine is stopped and allowed to cool. This oil mist will then condense on the plate and form a coating on the inside surface. When the engine is placed on load again, the heat of the piston may be sufficient to distill this trapped oil. When this operation takes place again and again, there may eventually come a time when the conditions existing between the plate and the piston head cause the oil residues to glow, or to become incandescent. A hot local section is set up in the crankcase, and it is safe to assume that if the oil mist around this section becomes highly heated, it will catch fire either from the hot plate or from a glowing deposit, provided the local mixture of oil vapor and air is in a proportion suitable to cause burning. As a result this local fire would immediately ignite the rest of the oil vapor in the crankcase, and an explosion would ensue. This theory is of necessity somewhat problematical, but nevertheless it would seem reasonable to suppose that an explosion may occur if proper attention is not given to the design, location and maintenance of the oil shield plate.

As cylinder sizes increase, the induced temperatures in the piston head and other parts become higher. In small engines the excess heat in the piston head is easily carried away, mostly by dissipation to the water-cooled cylinder walls, but in larger sizes this effect naturally becomes more limited and it becomes necessary to cool the piston by the circulation of either oil or water through passages in the piston head. It is better to water-cool the pistons than to cut down on the expense by installing oil shield plates. The induced heat may not be sufficient to cause piston trouble, but it may cause more or less rapid deterioration of the crankcase oil, which continually comes in contact with this section and is thereby overheated. It is a well-known fact that overheating of the oil will cause it to oxidize and deteriorate.

A hot bearing is another source from which an explosion may develop. If the bearing overheats to an appreciable extent, local heating of the oil mist will take place until a possible inflammable mixture of heated air and mist surrounds the bearing. A hot spark getting past a set of leaky piston rings and dropping into the crankcase might be sufficient to ignite this inflammable mixture, or a spark from the excessively overheated bearing might also set it on fire.

In discussing explosions it is well to bear in mind that conditions have to be ideal to cause them. For example, if the oil mist or spray in the crankcase is atomized into extremely small particles, it will be much easier to ignite than an oil spray that is not so finely atomized. Then, again, air has to be present in the correct proportion around the local heating spot or source of ignition to allow the original source of fire to take place. If the oil in the crankcase contains a percentage of fuel oil, it will ignite more readily than if none were present.

The engineer who operates a Diesel engine should not get the idea that his life is in constant danger. Diesel engines are probably much safer to operate than any other type of prime mover. Before concluding this discussion on the possible causes of Diesel-engine explosions, it might be well to state that they generally originate at a local spot and the cause can generally be traced to some section with a fault in design or extremely careless operation. In the main, however, serious explosions in Diesel engines are rare, and as designs become more perfect, their chances of taking are constantly becoming less. F. W. WILLIAMS.

New York City.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

"Thermofeed" Feed-Water Regulator

THE illustration shows a boiler feed-water regulator, known as the Thermofeed, recently developed by Ronald Trist & Company, Ltd., 56 Victoria Street, Westminster, London, S.W. 1, England. The regulator is made in marine and stationary types, the essential difference between the two being, that in the marine type the connections to the regulating element or float chambers are flanged and on the stationary type the connections are screwed. The latter type is illustrated herewith.

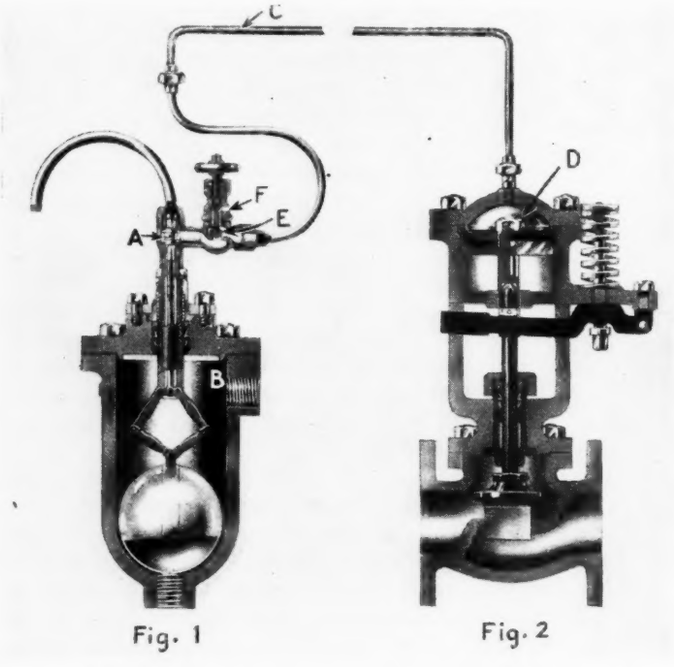
The regulator, which operates solely by the water level, consists essentially of two parts—the controlling element, Fig. 1, and the regulating valve, Fig. 2, with interconnecting piping as indicated.

In the controlling element, Fig. 1, which is connected directly with the steam and water space of the boiler, the double-ported valve *A* is operated by a float and suitable linkage as shown. This valve is designed to admit pressure from the float chamber *B* to the interconnecting pipe *C* and pressure chamber *D* of the regulating valve, Fig. 2, or to connect the line *C* and chamber *D* directly with the atmosphere. This operation in turn causes the regulating valve to open or close in direct relation to the changes in the water level of the boiler, and corresponding raising and lowering of the float.

The valve *E* is double-seated and serves to put the regulator in or out of service. By screwing the valve *E* down the pipe *C* is opened to the atmosphere through the vent *F* in the valve bonnet and thus permits the valve to open wide, in which case the feed is controlled by hand.

An important feature of the controlling mechanism is the provision made for pressure inside the float to counteract that on the outside. The float has inclosed and thermetically sealed within it a small quantity of water, which is converted into steam at the pressure to which the outside temperatures correspond, thus balancing the pressure on the float.

The float chamber, Fig. 1, is of cast iron. The float is of Monel metal or steel with toggle levers of manganese bronze and valve stem of gun metal. The regulating valve, Fig. 2, is gun metal lined with gun metal nickel alloy body and cast-iron yoke. Any desired variation in the water level is readily obtained by adjustment of a spring on the regulating valve.



Figs. 1 and 2—Section of controlling elements and regulating valve

"hp. Microhite" Hangers

SELF-ALIGNMENT of the bearings in the hanger illustrated is permitted by freedom to move both in the horizontal and vertical planes.

Bearing hanger with screw adjustment

After rough height adjustment has been made by sliding the shank in the base and locking it therein by means of setscrews, the final adjustment is made by means of the knurled collar which screws into the yoke. Both rough and fine lateral adjustments are made in the usual way by means of slotted holes in the base and the hanger screws.

Stock sizes range from bores of ½ to 1 in., and heights to the center line of 3½ to 10½ in. The range of bearing lengths is 2 to 2½ in. Both ball and bronze bearings, which are interchangeable, may be obtained. The hanger has been developed by the Hardware Products Company, 103 Richardson St., Boston, Mass., but will be handled exclusively by the Boston Gear Works Sales Company, Norfolk Downs, Mass.

Type B Flex-Ring Coupling

THE flexible coupling illustrated, known as the Style "B" Flex-Ring, has been brought out by the T. L. Smith Company to supplement its Flex-Ring heavy-duty full-floating

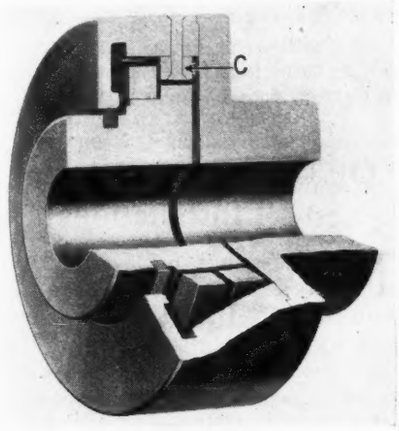
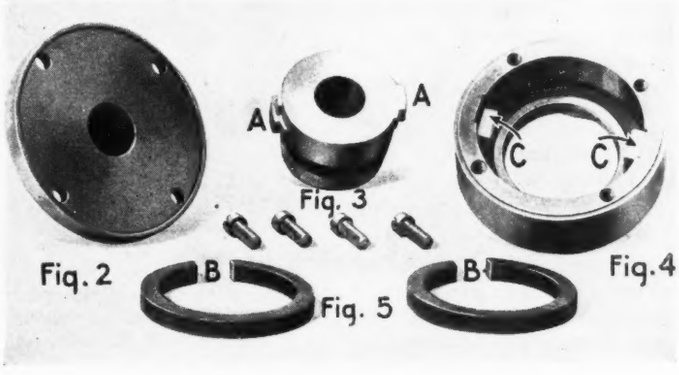


Fig. 1—Cut-away view of coupling assembly

coupling which was illustrated and described in the Oct. 16 issue.

In the style "B" coupling, flexibility is furnished by means of two long ring-shaped springs having a considerable degree of deflection. The hub (Fig. 3), which is made of cast steel, has two projections *AA* machined to fit the gaps *BB* in the driving springs Fig. 5. It is also provided with a recess for felt packing that retains the grease in the housing. The housing (Fig. 4) is made of semi-steel machined all over. It carries two keys



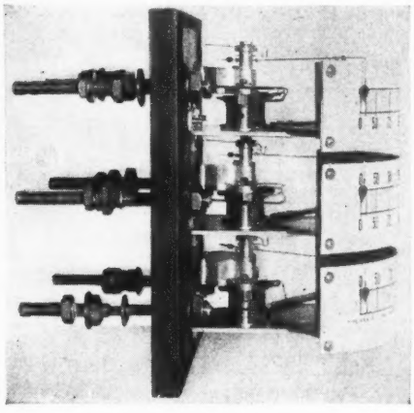
Figs. 2 to 5—Disassembled view of coupling

CC corresponding to the lugs *AA* on the hub. These keys are set into machined recesses in the housing and riveted into place as shown at *C*, Fig. 1. The flange (Fig. 2) is made of semi-steel.

The driving springs (Fig. 5) are of heat-treated spring steel, machined to fit over the projections *AA* on the hub and the keys *CC* in the housing. Flange and housing are bolted together, and all inside parts are held in position without the use of snap rings or bolts.

Polyphase Ammeter for Three-Phase Circuits

A POLYPHASE ammeter has recently been announced by the Roller-Smith Company, 233 Broadway, New York City. As shown in the figure, this meter consists of



Three metering elements are supported on a common base

three horizontal edgewise mechanisms, mounted one above another. These are mounted in a single case with a single window exposing all three scales. The three scales allow accurate comparison being made of the currents in the different phases of three-phase circuits, as three simultaneous readings can be taken. Another feature is the compact arrangement of the three metering elements, which is desirable for switchboard mounting where space is frequently at a premium.

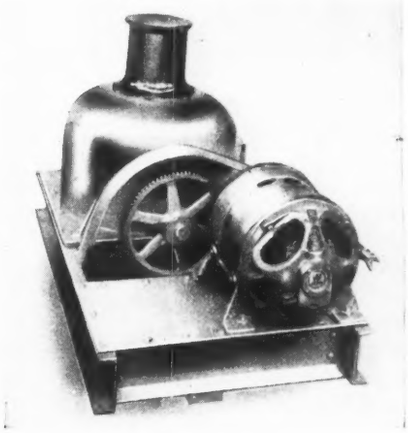
The three metering elements are of the standard electromagnetic type. Damping is obtained by a vane moving in an inclosed chamber. The three elements are magnetically shielded from one another so that there is no mutual interference.

For mounting the instrument it is only necessary to drill six holes in the switchboard, as the terminal studs act to support the meter. The case is finished in dull black rubberoid finish. The dials are of white bristol board with prominent black inscriptions, are well lighted and easily read. The scales are readable from about 20 to 100 per cent of full value. An accuracy to within about 1¼ per cent of full scale value at any point on the scale is obtained.

Vertical Capstan-Type Car Spotter

THE vertical capstan-type car spotter illustrated, known as 17 J, Jr., is a recent product of the Stephens-Adamson Manufacturing Company, Aurora, Ill.

The capstan is mounted on a rigid



Motor-driven vertical capstan-type car spotter

steel base made of riveted channel iron, and the motor bracket is mounted on a steel plate riveted to the channels to form part of the base. The bevel reduction gears are inclosed in a dustproof housing. The capstan has a speed of 15 r.p.m., exerts a pull of 2,000 lb. on the rope and is designed to move a car at the rate of 30 ft. per min. It is driven by a 5-hp. motor, and the weight complete is 1,075 pounds.

Combined CO_2, Draft and Flue-Gas Temperature Recorder

A NEW combustion meter, designated as model C, designed to record CO_2 in combination with either furnace draft or flue-gas temperature or as a combined recorder for CO_2, draft and flue-gas temperature, has been announced by the Hays Corporation, Michigan City, Indiana.

The Orsat principle of operation, as used in former types, is retained in the new model, the changes having been made in the recording rather than the analyzing parts. Suspended pens, a ten-inch circular chart and a new silhouette-type aluminum chart case with polished aluminum door are features of the new model. Another feature is the draft attachment, the pen of which is actuated by a special slack leather diaphragm as used in Hays pointer-type draft and pressure gages. With this mechanism, the most sensitive range gives a pen movement of two and one-half inches with a draft of two-tenths of an inch of water.

Model C combustion meter

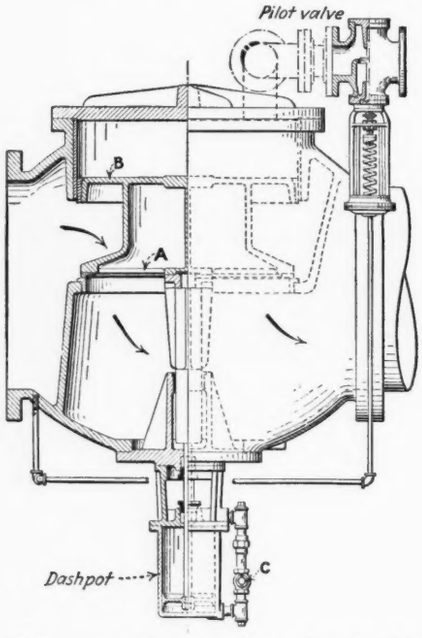
The model C instrument is furnished completely equipped with ink, 100 charts, six to eight months' charge of caustic potash solution in liquid form, water strainer, double-length porous carborundum soot filter and wall sleeve for making the filter easily removable.

Where water conditions are bad or where a portable CO_2 recorder is desired for periodic tests on several boilers, the meter can be furnished with a motor-driven pump to recirculate water from a three-gallon tank mounted inside the supporting base of the instrument. For portable work a special three-wheel truck is furnished.

Pilot-Actuated Back-Pressure Valve

THE Atwood & Morrill Company, Salem, Mass., has recently added to its line of valves the pilot-actuated back-pressure valve illustrated.

The valve is designed for instantly relieving any pressures up to 250 lb. It is fitted with a flat-seat poppet *A* to which is rigidly connected the piston *B* of somewhat larger diameter.



Pilot controls operation of valve by releasing or holding pressure above piston attached to valve disk

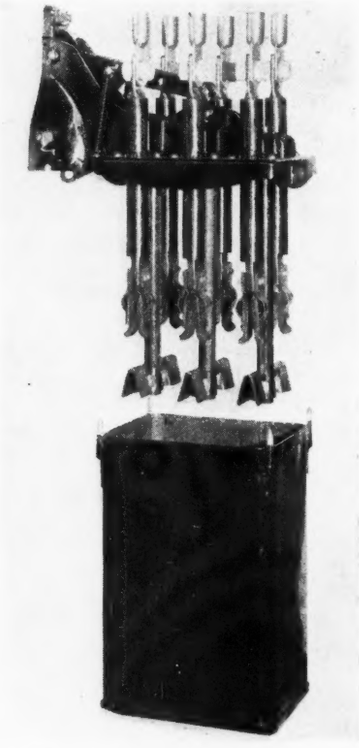
The operation of the valve is controlled by holding or relieving the pressure from the chamber above this piston by means of a pilot valve. The pressure chamber below the diaphragm of the pilot valve is connected to the inlet side of the valve. When the pressure reaches a predetermined point, the diaphragm is forced upward and this in turn causes the pilot valve to be pushed open and the pressure released from the chamber above the piston *B* to the atmosphere. When this takes place, the pressure acting on the difference in area between piston *B* and the disk *A* forces the valve open. Then, when the pressure is lowered, the pilot valve closes, the pressure builds up in the chamber above the piston and the valve is held closed, the steam passing to this chamber around the clearance of the piston *B*.

A cushion chamber or dashpot is connected to the lower end of the valve spindle. This chamber is fitted with a cock bypass which can be set to regulate the speed at which the valve will open or close and to obviate shocks.

The valve is made in standard pipe sizes from 6 to 28 inches.

Oil Circuit Breaker for Small Installations

TYPE FK-33 is the designation of a new oil circuit breaker announced by the General Electric Company for manual or electric operation. These devices are rated 4,500 volts, 200 and 400 amperes, two, three and four poles, single- and double-throw and have interrupting capacities of approximately 20,000 kilovolt-ampere.



Small-capacity oil circuit breaker for manual or electric operation

This oil circuit breaker is recommended for use in small plant and industrial installations and for stations where a reliable breaker of moderate interrupting capacity is required. The breakers are compact in design, have small over-all dimensions, are easy to operate and are low in cost.

Here Are Facts That Form

A Basis for Stoker Selection

IT IS a fallacy to believe that one type of stoker can be used for all types of installations and fuels. Stokers can be divided into six classes, all distinctly different and adapted to different uses. They are:

1. Hand or semi-automatic.
2. Overfeed, inclined, or V-type.
3. Natural-draft chain or traveling grate.
4. Industrial underfeed, single, double or lateral retort.
5. Forced-draft chain or traveling grate.
6. Multiple-retort underfeed.

These six types divide themselves roughly into two classes of installations: A, the lightly loaded, short-hour, or low-load-factor industrial plant, and B, the heavy-duty, continuously operating, central-station or industrial. Stokers of types 1 and 2 belong naturally in plant A class, while stokers of types 5 and 6 are adapted to plants in class B exclusively. Stokers of types 3 and 4 may be used in either class of plant, depending on their size and how definitely the work to be done approaches class A or B.

A description of the duties and fuels for which each type is best adapted and what conditions it cannot be expected to meet follows:

Hand Stokers

This type of stoker is only slightly better than hand-firing, being relatively low in efficiency and adapted only to excellent low-ash coals of nut size and larger. High rates of combustion cannot be obtained; they are sensitive to fire thickness and require a relatively great amount of draft in comparison to the amount of coal that can be burned per square foot of grate. The condition of the fire is harder to determine than with hand-fires, and their tendency to avalanche leaves bare spots causing a large wastage of fuel into the ashpit. The danger of too heavy fires is likely to result in an almost complete stoppage of combustion. Smoke is nearly always emitted, so that they will rarely pass city smoke-prevention ordinances.

Their advantage over hand-fired grates is that they do not require the frequent opening of firedoors for feeding coal, so that large amounts of excess air are not admitted during firing periods and fuel feeding is more uniform than with hand-fires. A poor fireman will get better results with this type of stoker than he would when hand-firing, but a good fireman will do about as well with either equipment. These hand-stokers should be used only in low-load-factor low-rating plants, with good fuel, nut size or larger, and where the cost of fuel and the type of installation do not permit a large investment.

Overfeed, Inclined or V-Type Stokers

The operating characteristics and application of both the front-inclined and the V-type overfeed stokers are almost identical, so that they can be treated as one type. They were the ones most generally in use in the East ten to fifteen years ago, even in large plants.

They are adapted to low-ash high-grade coals, particularly of the semi-bituminous varieties. Their tendency to avalanche, the sudden appearance of bare spots, the high combustible in the ash when forced even with low-ash coals, and the high draft required for relatively low rates of combustion make these stokers limited in their adaptability. They are unsuited for such coals as Pittsburgh No. 8 and Ohio No. 6. Furnace temperatures must be maintained high to obviate smoke, making them difficult to operate at low ratings.

These stokers, however, are quick to respond to manipulation, especially if they are "rousted." They are free from dust and cinders in the boiler room and are simple and quiet in operation. For loads such as are encountered in hospitals, schools and office buildings, with low-ash West Virginia and eastern Kentucky coals, at ratings varying from 15 lb. to not over 25 lb. per square foot of projected grate area, these stokers have shown excellent results in efficiency and operating satisfaction. Their maintenance cost is high, increasing rapidly with the rates of coal burned.

Theodore Maynz gave a summary of many years' experience with many types of stokers in a paper read before the second annual National Fuels Meeting of the American Society of Mechanical Engineers, Cleveland, Ohio, Sept. 17 to 20, 1928. This is an abstract of his paper.

Natural-Draft Chain or Traveling-Grate Stokers

Used almost exclusively for many years in the West and Middle West to burn the high-ash clinkering coals of these regions, natural-draft chain or traveling-grate stokers are still being operated in both central stations under large boilers and in industrial plants under boilers as small as 150-hp. rating. They are adaptable to any coal having 12 per cent ash or more, but are a failure when handling low-ash Eastern bituminous and semi-bituminous coals. The free-burning coals are easiest to handle and maintain uniform fire conditions, coking coals tending to uneven fires.

These stokers are extremely sensitive to furnace design, are sluggish in picking up peak loads, hard to bank, and rather high in maintenance. They are not flexible, as under low ratings the excess air is high and furnace temperatures low, while at high ratings the combustible in the ash is excessive. Quite often, when forced, they will lose their ignition, necessitating a temporary shutdown. With wide furnaces it is difficult to maintain an even fuel bed, even when split gates are used. Where furnaces are wider than 12 ft., two stokers with a dividing wall are required, with the attendant high maintenance cost on brickwork.

To maintain a reasonable ashpit loss, water-backs are required. To keep down the excess air through the rear end, sealed ashpits and cutoff dampers in the rear end are necessary. The height of the water-back above the grate is important, as a change of less than one-half inch may make the ashpit loss excessive or stop up the grate with clinker. The siftings from these stokers are a nuisance. They tend to spoil the fires when fed back into the hopper, and as they amount to about 5 per cent of the coal and have a heating value in excess of 75 per cent of the fuel, they cannot be economically discarded.

Wetting to obtain a total moisture content of about 7 per cent seems to have a beneficial effect with most coals. There is a definite relationship between the coal used and the excess air for best results. With Pittsburgh No. 8, maintaining less than 50 per cent excess air increases the ashpit loss, so that the highest over-all efficiency is not obtained. The clinkering of coal along the side walls tends to keep the edges bare and to erode the brickwork.

It is especially difficult to maintain an even fuel bed with stokers having coking plates for fuel feeding. Holes in the fire are rare, but when they do appear it is impossible to cover them without using a bar, and by the time a bar can be used, the holes are past the middle of the grate. With grates 12 ft. long it requires at least a half-hour before the operators get any results from a

change in the fuel feed. With coals having 35 per cent or more volatile, quite high rates of combustion can be obtained; 40 lb. per square foot of grate is not uncommon.

These stokers are adapted to steady loads and poor grades of clinkering coal under medium-sized boilers. However, they are being displaced by the forced-draft traveling grates and are now obsolete.

Industrial-Type Underfeed Stokers

The number of installations of industrial-type underfeed stoker, under varied conditions, different coals and under various sizes of boilers, makes one almost inclined to call it the universal stoker for medium- and small-sized plants, both central-station type and industrial. There are sizes varying from one for a small house-heating boiler, consisting of a screw and some tuyeres, to installations under boilers of over 10,000 sq.ft. surface. Coals varying from the Eastern semi-bituminous to the high-volatile, high-ash coals of the Middle West can be used. These stokers seem to be adapted to a larger variation in coals and conditions than any other type.

The chief advantage of the industrial underfeed stoker is its ease of application to both new and old installations, coupled with comparatively high operating efficiencies. Since a basement ashpit is not required, they can be applied to almost any boiler. Built low, their installation under low-set boilers allows smokeless operation and good efficiency under these conditions. They are inherently smokeless, so that in this particular they have given excellent results. Their operation requires less skill than any other type of stoker.

In the larger sizes they have movable grates on the overfeed section, so that the coked coal is worked down to the side dumping plates, combustion advancing progressively. As the amount or area of this overfeed section is quite important, best results are obtained from wide, rather than deep, stokers.

Best operation is obtained by using thin fires so that the action of the moving grate bars benefits the fuel bed, as heavy fires nullify this action. This applies to practically all coals. Front and bridge-wall clinker are detrimental, disturb the even covering of the grates, and are very hard to remove while operating. The ease with which a fireman can use a slice bar to level off and disturb the fuel bed (mostly unnecessary) is an objectionable feature, causing smoke and clinker.

The construction is such that there is little possibility of a breakdown requiring the immediate shutdown of the boiler, as they can be hand-fired if necessary. Front and bridge-wall air under pressure, controlled by dampers, is useful in preventing smoke under low-set boilers, but is generally used in excess, lowering the CO_2. Non-perforated carborundum air-cooled blocks along the clinker line are useful with low-fusion coals. Like all underfeeds, front-wall clinker, coupled with a thin fire at the front, will cause distillation of coal in the hopper and send fumes into the boiler room.

Although test efficiencies in excess of 75 per cent have often been obtained, 63 per cent over-all is about as good an operating efficiency as can be expected from the average installation. With the use of adequate meters, furnace-draft regulators and competent supervision, 67 per cent to as high as 70 per cent can be continuously maintained.

Continuous combustion rates in excess of 40 lb. per square foot of grate should never be attempted, even with high-fusion, low-ash coals, and considerably less than this with poorer coals. Maintenance is remarkably low when high combustion rates are not attempted, but, as with all stokers, increases very rapidly when operation is forced. The flexibility is all that can be desired, these stokers reacting quickly to load changes. Banking is easy and pick-up from dead or live bank is rapid, requiring no manipulation such as bearing or rousting of fires. Using the equation of $A + BX$ for the banking loss, both coefficients are low, the coefficient A being the lowest for any type of stoker.

The forced-draft traveling grate is the only stoker suitable for anthracite and coke breeze. According to Theodore Maynz, its advantage for bituminous coal occurs when the fusing point of the ash and its clinker is such that excessively large stokers of the underfeed type must be used.

For small boilers of 1,000 to 2,000 sq.ft. surface these stokers are built without grate-bar motion and in some cases without dumping plates. Having operated several makes of this small-size stoker, the author is convinced that the elimination of both these features is a serious mistake. The coal heaps up on the retort, does not distribute, tends to heavy fires over the retort and excess air through the grates, and always causes the use of the bar by the fireman, resulting in smoke and clinker. The elimination of dump plates means pulling the clinkers through the front doors with a hook, always a bad operating condition.

Those stokers with built-in fan and electric drive are most convenient for small plants. It has been the experience of the author that the convenience of electric drive in small plants more than balances the lower operating cost of steam drive exhausting into the feed heater or heating system.

Wherever the industrial underfeed stoker has been pronounced a failure, the underlying cause has been either too small a stoker for the load or type of coal or incorrect furnace design.

Forced-Draft Traveling-Grates

The forced-draft traveling-grate stoker is the only one adapted to burning anthracite, coke breeze or mixtures of these fuels with bituminous coal. Burning out the combustible of these fuels is dependent on reflected heat, so that both front and rear arches are required. The time element is important, so that a relatively long stoker gives the best results. Careful furnace design is essential; the furnace is expensive, as the total length of arches is nearly equal to the stoker. To prevent loss of ignition at high rates of combustion, a slight positive pressure in the furnace is required, which tends to a bad boiler-room atmosphere.

With all fuels thorough air sealing of the ashpit is required, and the use of water-backs is an advantage, especially with bituminous coals. Water-cooled side walls at the clinker line or carborundum brick, preferably air-cooled but not perforated, are a distinct operating help. In spite of the zoning of the stoker three separate types of combustion occur—deficiency of air at the front, excess air at the rear and normal in the middle. This means that the furnace must act as a mixing chamber, more so than with other types, and large volumes are essential. Furnace temperatures must remain high at all rates for smokeless combustion. The ashpit loss is inversely proportional to the time element, so that long stokers operating at low speeds give the lowest combustible in the refuse. This requires that the last compartment be operated with its air damper closed practically all the time.

Flexibility in operation and response to load changes is much better than with natural-draft chain grates, but both in this respect and in banking they do not compare favorably to the underfeeds. In one plant where nightly banking was required, the maintenance of refractory gates was so high that water-cooled gates had to be used. Approximately one hour is usually required to bring up the stokers from bank to normal operation.

This type of stoker requires skilled operators—the type usually found in central stations—trained and supervised by combustion engineers. With several compartments requiring different air pressures, varying speeds of travel and different fire thicknesses, the operation of these stokers without trained personnel and a complement of instruments spells failure.

Multiple-Retort Stokers

Probably the greatest improvements in stokers have been made in the multiple-retort type. Since this type, more than others, has been used by the larger central stations, their trained engineers have observed the various faults and either have suggested or themselves have made the improvements that are now incorporated.

Although to some purchasers of this

type of stoker they all seem similar, to experienced users there is an appreciable difference in the various makes. There does not seem to be a great difference in the purely underfeed part of these stokers, but the design of the tail end and dumping action shows some distinct operation advantages and disadvantages. Some have a section of overfeed grates to burn the coked coal, while in others this is eliminated, the underfeed retorts discharging directly on the dump plates. For ash discharge, single and double pump plates, reciprocating apron and single and double clinker grinders are used.

The author has had no practical operating experience with clinker grinders on underfeeds, all his information coming from other operators. This information has led to the conclusion that the double-roll grinders are far superior to the single-roll, and that in no case should either type be installed without water-backs. There is no question that the combustible in the ash is much lower with grinders than with dump plates, and for large installations and high-load factors the very considerable increase in investment is justified.

It is the author's conclusion that the elimination of the overfeed section is a mistake, even though the maintenance of this part is high. In one make of stoker without overfeed, burning Pittsburgh No. 8 coal at rates of less than 40 lb. per square foot of projected grate area, the compacting of the fuel bed at the tail end of the stoker requires the shaking of the front dump plate at frequent intervals.

With double-dump-plate stokers and low-fusing coals the adherence of clinker to the bridge wall is bad. Often the clinker fuses into a solid mass from the front dumps to the wall, so that cleaning fires at high ratings is a nightmare. The use of water-jets discharging into the furnace through the bridge wall cures this trouble and permits normal operation, but at an expense. The author doubts whether the single-dump stokers with clinker-shearing dump plates will adequately take care of this condition, but there is no doubt that such plates are much better under these conditions than the bridge-wall type. The use of perforated clinker block in the bridge wall is not considered correct, as there is always more than sufficient air in this part of the furnace, any addition being detrimental to best operation.

With apron dumps the correct opening must be maintained, so that the ash-pit loss is a minimum. As this opening varies with the coal and the rate of combustion, their proper operation requires more care than with intermittent dumping. With care the ashpit loss from this type of dump is probably lower than with any other type, clinker grinders excepted.

The multiple-retort underfeed stokers are capable of efficiently burning practically all types of bituminous coals. When all factors are considered, they are cheaper to install under large boilers for high outputs than other types of high-duty stokers.

With properly engineered installations, higher efficiencies, both test and daily operation, can be obtained on multiple-retort stokers than on any other type of stoker. Low efficiencies are usually owing to improper installation rather than to poor operation. Experience has taught the author that a job has rarely been handicapped by judicious over-stokering and that a small amount of increased first cost is more than made up in decreased maintenance.

Banking is easy and is attended with small losses. Coming out of a dead bank is very quick, and some remarkable results have been published. The author personally never has been able to duplicate them, but nevertheless has been able to obtain higher ratings from both live and dead banks with multiple-retort stokers, in shorter periods, than with any other type of stoker. Care in banking is required so that the coal does not burn back into the retorts, otherwise serious burn-outs of the stoker will occur. In fact, more damage can result from careless banking than from high ratings. The losses are low, but greater than with equivalent size single-retort stokers.

The smoking or fuming from stoker hoppers, usually caused by front-wall clinker and thin fires, is a nuisance. Although this occurs with all underfeeds, it seems to be more frequent with multiple-retort stokers.

Although over 70 lb. of coal has been burned per square foot, it is unwise to exceed a maximum of 50 lb. even with the best of coals. The author limited a recent installation, burning a high-grade low-ash eastern Kentucky coal, to 35 lb. at the maximum continuous rating. Efficiencies of over 80 per cent have been obtained without economizers or preheaters, but an average of 72 to 73 per cent combined efficiency at normal ratings with average fluctuations is as high as should be expected, even with proper instruments and good operators. Where the conditions and personnel warrant the use of very efficient combustion controls, these figures are of course exceeded.

Heat Transfer in Ammonia Condensers

TESTS conducted on vertical shell-and-tube ammonia condensers are described in Bulletin 180, published by the University of Illinois.

These tests, by H. J. Macintire, Alonzo P. Kratz and R. E. Gould, reveal a number of interesting facts. The condenser contained thirty 2-in. tubes, 16 ft. long, with a total condensing surface of 251 sq.ft. This surface was reduced in some of the tests by raising the liquid level and by plugging up some of the tubes.

With the 251 sq.ft. in operation, it was found that at a constant rate of water flow K, the average coefficient of heat transfer per square foot per hour per degree of temperature difference, decreased, while the mean temperature difference between the water and the ammonia increased. The decrease in K was due to the increase in the film of ammonia trickling down the outside of the tube.

It was found that the maximum condensation, as indicated by the increase in the water temperature, occurred within 6 ft. of the top of the shell, and 9.5 ft. from the top. The difference between the ammonia and water temperatures was only 1.5 deg. F. Possibly the condenser could have been made shorter without sacrifice in performance. The investigators concluded that the condenser tonnage developed per square foot of surface is independent of the size or proportions of the condenser and is a function only of the water initial temperature and of the amount of water.

It was found that a given surface was approximately eight times as effective in removing heat from saturated vapor as it was in desuperheating ammonia.

When compared to other tests previously run on double-pipe condensers, it was found that the surface of the double-pipe condenser was slightly more effective, but that even radically different arrangement of surfaces as represented by the different types of condensers had no very decided effect on the performance when reduced to unit bases. Furthermore, for condensers having the same amounts of condensing surface, approximately the same total tonnage may be expected to be developed for any given initial temperature water available, when it is possible to circulate the same amount of water per unit of surface.

The condenser tonnage developed per square foot of surface in the shell and tube condenser is independent of the size or proportions of the condenser used in this investigation and is a function only of the initial temperature of the water and the amount circulated per square foot of surface per unit of time.

The condenser tonnage developed per square foot of surface in the condensers, when the effective surface was altered by raising the liquid level or by plugging pumps, as was done in this investigation, was approximately the same regardless of proportions or arrangement of surface if a given amount of water at a given initial temperature was circulated per square foot in a given time.

Coal Salesmen Need Technical Knowledge

Purchasers entitled to expert services, Coal Association is told

AT THE eleventh annual convention of the National Coal Association held in November, a paper dealing with the need for more scientific merchandising of coal was read by T. W. Harris, Jr., purchasing agent, E. I. du Pont de Nemours & Company, and vice-president of the National Association of Purchasing Agents. Purchasing agents of large consumers, Mr. Harris pointed out, are more and more becoming specialists in fuel combustion and fuel sources, and salesmen, if not technically trained, should at least understand the principles of combustion. In the speaker's opinion the duty devolved upon progressive coal producers and associations to foster a type of salesmen who would be welcome in the boiler room and respected in the front office.

"Does it seem logical," he asked, "that the customer must, without assistance from the coal industry ferret out the coal best suited for his requirements through testing various coals, studying seams and fields and many other varying conditions, when it would be possible for the coal companies through their salesmen to establish where their coals are best suited for various customers' requirements and render to the customer the proper service?"

With each power house showing variations in boiler and furnace design, burning equipment, load character and storage requirements, it does not seem possible, the speaker said, to lay down hard-and-fast rules for the "classification of coals as to their suitability for stationary steam generation." In this statement he quoted Messrs. Flagg and Calkins for the technical committee on use classification of the Committee on Coal Classification sponsored by the A.S.T.M. This situation makes it advisable that each coal company classify its own product in accordance with consumers' requirements.

"Salesmen," said Mr. Harris, "should be armed with all necessary data on the physical and chemical characteristics of the fuel sold and the application of the fuel to specific requirements. Accurate analyses of coal as shipped and not analyses of coal at the face, should be furnished. These analyses should be made by or for the coal company and the producer should establish such a reputation for integrity that its analyses would be accepted without question."

Buying and selling are companionate functions. Where purchasers refuse the salesman access to the power plant or withhold information on their combustion problems, the situation, Mr. Harris believed, "is as much the result of incompetent selling as it is incompetent buying. In many cases it is on account of many unfortunate experiences which purchasing agents have had, due to the lack of knowledge or improper tactics on the part of salesmen."

The concluding portions of Mr. Harris' address were concerned with a presentation of the proposed buying code recently formulated by a committee sponsored by the National Association of Purchasing Agents.

In floor discussion following the speech, the idea of the employment of combustion specialists by coal producers was favorably received, and a number of delegates stated they had found such men a valuable addition to the sales staff. The men so employed, said H. N. Taylor, president, Sheridan-Wyoming Coal Co., must be diplomats of high order as well as salesmen and combustion experts. Unless diplomacy is added to their qualifications, their work may appear a reflection upon the initiative and ability of the boiler room personnel of the purchaser and create a spirit of antagonism fatal to future good relations.

Accurate and detailed knowledge of the characteristics of the coal sold and the application of that coal to specific jobs also was set up as an essential part of a proper merchandising plan by H. A. Glover, vice-president of the Knox Consolidated Coal Company and chairman of the marketing committee of the National Coal Association. Mr. Glover stressed the necessity for larger producing and selling units and emphasized the desirability of all sales being under the direct control of the producer or his exclusive selling agent. Shipment of coal on consignment was generally condemned.

That the stabilization of the bituminous coal industry will mean higher prices at the outset was suggested by two of the men who addressed the convention. Discussing the cost of maintaining excess capacity, S. A. Taylor, past-president of the A.I.M.E., estimated that it would cost approximately $250,000,000 annually to carry the nonproductive load and check present ruinous competition. The same figure was suggested by F. W. Shibley, vice-president, Bankers' Trust Company, who urged an educational campaign to teach the industry and the public the real situation.

Both speakers voiced the thought that the public was willing to pay a fair price for fuel. "A fair return," said Mr. Shibley, "is not being earned upon the capital actively employed in the coal industry and labor is not being permitted to earn wages commensurate with the cost of living in this country or comparable with the wages paid by successful industries. Consumers of coal, in particular the railroads, public-service corporations and manufacturers, must be educated in the knowledge of co-operation so that they will realize that they are enemies of their own enterprises when they stifle the purchasing capacity of all those connected with the coal industry.

"Instead of purchasing necessitous coal at prices yielding a profit to no one, the public-service corporations and manufacturers generally would find that in paying an equitable price for coal they were stimulating consumer capacity for their own service and products, that the business of the nation was being strengthened and the national prosperity increased. Miners, like other well-paid workmen, would contribute to the national purchasing power.

"And right here it should be stated that the predictions recently made of a broadening national prosperity by Charles M. Schwab and Henry Ford can never materialize as long as certain classes of capital and labor are pauperized through a persistence of uneconomic conditions. The coal industry is one of the greatest national industries. The agricultural industry is the greatest of all industries. There can be no extended national prosperity until each of them receives his fair share of the national dollar of income."

Atomic Layers

FROM time to time unusual accomplishments have been made in the measurement of minute quantities, but even the most startling of these, it seems, must fall before the measurement of a layer of metallic rubidium one atom thick recently accomplished at the Bell Telephone Laboratories, according to *Science*.

In the course of researches on how to make the photoelectric cell most efficient, A. L. Johnsrud measured the thin films. When the thin film of metal inside the glass cell was very thin it operated better than when thicker. Rubidium can be made into thin films more easily than its relative metals, because at rather low temperatures and without loss of time it can be made to evaporate and the vapor deposited, in a vacuum, to form such a film.

A large photoelectric cell was made and so arranged that rubidium could gradually be deposited on the glass, or else, after a thick deposit had been made, it could gradually be removed. While the film was thus getting thicker or thinner, the photoelectric response, the current given off when light fell on it, could be measured. Since the maximum response was obtained at the same point; whether the film was growing thicker or thinner, it was necessary exactly to record the film's depth.

Ordinary measuring methods proved inadequate and polarized light was used. When polarized light passes through any film, such as the one of rubidium, the direction in which it vibrates is twisted. The thicker the film the more it is twisted. By means of another prism similar to that which polarizes the light, the extent of the twisting, and also the thickness of the film, are measured. The most current was obtained with a film one atom thick.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Novel Refrigerating Systems Discussed At A.S.R.E. Convention

Four Day Meeting Brings Several New Refrigerating Schemes to Light

AN ADDRESS by the president, George B. Bright, and a business session marked the opening of the 24th annual meeting of the American Society of Refrigerating Engineers in New York City on Dec. 5.

Opening Session

At the opening technical session two papers were presented and discussed at length. The first, "Thermal Processes in Petroleum Refining," by Dr. Rudolph Plank, of Germany, was presented by Robert Brandt. Doctor Plank gave credit to L. Edeleanu, a German physical chemist, for some of the most important developments affecting oil refining. The Edeleanu process involves the discovery that the selectivity of a solvent toward different hydrocarbons may increase with a decreasing temperature. He discovered also that sulphur dioxide had qualities superior to sulphuric acid, used exclusively before the War. At the same time much less solvent is required. The combination of a low-temperature process and a machine requiring sulphur dioxide naturally suggests a new development for sulphur-dioxide refrigeration, which has not been used on a large scale in this country for many years.

The paper on "Heat Transfer in Multitube-Multipass Ammonia Condensers," by Kratz, MacIntire and Gould, of the University of Illinois, was discussed at length, from the angles of the comparative merits of different types of apparatus, the different means of analysis of heat transmission effects and heat transmission theory in general.

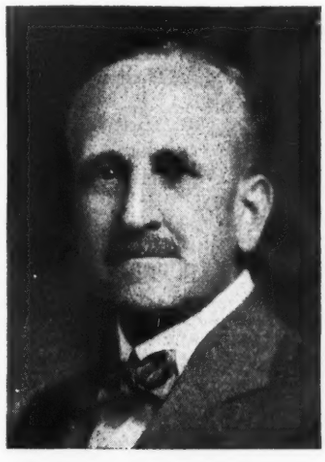
Special Evening Session

The members of the Society assembled Wednesday evening to hear a paper on "The Economical Use of Fins," by N. S. Diamant, a consulting engineer from Detroit. At the conclusion of this paper a lecture was delivered in interesting style on the application of welding to modern manufacturing. This was delivered by A. M. Candy, an engineer of the Westinghouse Electric & Manufacturing Company.

Mr. Candy described the use of welding in the fields of both machinery manufacture and structures and discussed the economic features as well as construction details, showing a large number of pictures.

Second-Day Session and Trip

The field of application of refrigeration was treated in the session of Thursday morning by three papers. E. H. Ford, of Syracuse, N. Y., read a paper on the application of refrigeration to dairies and creameries. This paper dealt with the design of typical boxes and went into practical considerations affecting it. The trend of the discussion was toward the question of adapting the proper machine to the job required, in view of economical as well as purely technical questions. Several believed that the brine tank was incorrectly designed, and it was suggested that the brine be frozen to permit the use of a smaller tank.



Prof. A. J. Wood
New President, A.S.R.E.

Crosby Field read a paper on the development of a machine for producing ice continuously, by a rapid process. His apparatus is called a "Flakice" machine, since the product is generally in the form of small pieces of sheet ice, made on a revolving brine-filled roller. It is claimed that the ice is ideal for vegetable and ice cream packing purposes.

A paper pointing out the field for refrigeration for the farmer was presented by Dr. J. B. Churchill on behalf of the author, W. T. Ackerman, agricultural engineer of the University of New Hampshire. This paper was not discussed at length owing to the considerable time given over to the discussion of Mr. Field's paper.

On Thursday afternoon, a party visited the U. S. Navy Yard in Brooklyn, particularly to see the refrigerating equipment on a navy supply vessel, as well as other features of the yard.

The annual joint meeting of the refrigerating engineers and the mechanical engineers was held Friday morning, at which time two papers were presented. "Freight Car Refrigeration by an Adsorption System Employing Silica Gel," by George E. Hulse, created much interest. In place of the usual ice bunker two sets of tubes filled with silica gel are placed in a closed compartment at one end of the car. Evaporating coils are placed inside the car just under the roof, and a set of condenser tubes are placed on the roof. The sulphur dioxide evaporates in the evaporating coils and is absorbed by the silica gel. After one of the gel holders is completely charged, a gas burner is turned on automatically and the heat drives the vapor out of the gel into the condenser tubes.

Joseph S. Slepanor presented "A Graphical Treatment of Heat Exchange Problems." In this paper the author developed a set of curves to represent heat formulas, thus avoiding laborious calculations.

Friday night was, as usual, taken up with the annual banquet, a most successful affair. Saturday several papers dealing with essentially household refrigerator work were presented.

The officers elected for the coming year are: President, Arthur J. Wood, professor of mechanical engineering, Pennsylvania State College; vice-president, Alvin H. Baer, Fuch Company; treasurer, George A. Horne.

Frank B. Jewett Receives Edison Medal

The Edison Medal has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Dr. Frank B. Jewett, "for his contributions to the art of electrical communication." Doctor Jewett is a vice-president of the American Telephone & Telegraph Company, and president of Bell Telephone Laboratories, Inc.. He graduated from Throop Polytechnic Institute (now the California Institute of Technology), and later took up graduate work at the University of Chicago under Prof. A. A. Michelson, receiving his Ph.D, in 1902. In 1904 he joined the staff of the American Telephone & Telegraph Company, and soon after was given charge of engi-

neering research work. In 1912 he became assistant chief engineer of the Western Electric Company, and in 1916, chief engineer. Six years later he became vice-president of the company. In 1925 he was elected vice-president of the American Telephone & Telegraph Company in direct charge of development and research. At the same time, he was made president of the Bell Telephone Laboratories, Inc.

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," by a committee consisting of twenty-four members of the American Institute of Electrical Engineers.

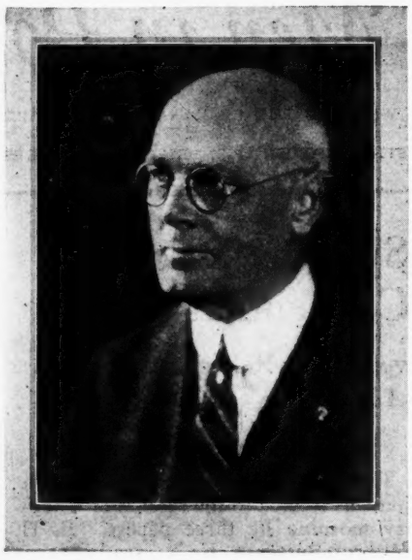
Canadian Mineral Industries Large Users of Hydro Power

The rapid growth of the use of water power in the mineral industries of Canada is indicated in a bulletin just issued by the Dominion Water Power and Reclamation Service. Of the total power installation of 131,965 hp. reported as used by the companies operating in the province of Quebec during 1926 (the period covered by the latest power statistics published by the Dominion Bureau of Statistics), over 95 per cent was water power, approximately three-fifths of which was purchased in the form of hydro electricity from central electric station organizations.

Ontario ranks first among the provinces in diversity and value of mineral production, and like Quebec, depends almost entirely on the abundant supplies of hydraulic and hydro-electric energy which are available to every field. The diversity of application of hydraulic power to mineral production in Ontario is indicated by the statement that of the twenty-odd active divisions of production only four are not energized by hydro power, while the preponderance of use is shown by approximately 148,000 hp. of the 173,000 hp. reported employed, being hydro power produced or purchased by the mining companies.

In the province of Manitoba recent mining developments have led to the construction of a 42-mile transmission line by the Manitoba Power Company to convey power under a twenty-year contract from the Great Falls station on the Winnipeg River to the mines of the Central Manitoba Mines, Limited. In Saskatchewan the leasing of Island Falls on the Churchill river has been negotiated to supply power for the mining operations of the Whitney interests at Flin Flon.

The large-scale operations for the recovery of zinc, copper and lead, carried on in the Kootenay district of British Columbia by the Consolidated Mining & Smelting Company of Canada, Limited, are supplied with power from two plants on the Kootenay River with an aggregate installation of 94,000 hp. and one on the Kettle river of 3,900 hp.



F. R. Low Presented With Telescope

The fortieth anniversary of Fred R. Low's editorship of *Power*, celebrated in the Oct. 2 issue, was commemorated in a more personal way by his colleagues on Dec. 7, at a luncheon given the veteran editor in New York City. The feature of the occasion was the presentation to Mr. Low of a 3⅛-in. portable telescope, a gift which was in line with his long-standing interest in astronomy.

Many officials of the McGraw-Hill Company were present at the luncheon, as well as the entire staff of *Power*. The speeches were numerous and short, and carried a consistent message of appreciation of Mr. Low's long term of editorial leadership, as well as his great influence in the engineering field.

The telescope was a tripod-mounted instrument made by the Bausch & Lomb Optical Company and was provided with three eyepieces giving magnifying powers of 32, 48 and 96 diameters, respectively. An erecting system was provided, together with sun glass, ray filter and folding tripod.

In the News

Hearings before the Federal Power Commission on the Cumberland Falls project in Kentucky, have brought forth considerable asperity on the part of nature lovers in all parts of the country. It seems to be the layman's idea that the engineer cannot see beyond the kilowatt and the B.t.u. Yet it is the engineer alone who can bring profitable industrial employment to that poverty-stricken section, and who proposes to do it by increasing the beauty of the place, not by destroying it.

Fuel from Farms A Future Possibility

All the fuel in the world may some day be grown in crops, Dr. Charles M. A. Stine, chemical director, E. I. du Pont de Nemours & Company, told the tenth annual meeting of the American Farm Bureau Federation at Chicago recently.

He pictured great areas devoted to the rapid growth of an enormous volume of vegetation as a cheap method of supplying a combination of hydrogen and carbon, and near-by huge chemical factories transforming the crop into fuel. While this development may be distant in time, it is not quite so fanciful, he said, as might appear.

Doctor Stine pointed out that industry may demand raw materials which originate upon the farm for the manufacture of synthetic products. "What would be more logical," he asked, "than that applied science should develop new products dependent upon growth of new crops demanding increased acreage for the supply of the raw materials required?"

The development of the potentialities of the nation's farms from the standpoint of their usefulness for the nation's factories, as well as for the growth of foodstuffs, calls for long continued and unbroken effort available only in government laboratories, he declared.

"While there are definite commercial factory outlets for some of the farm's waste products," he said, "estimating the total of farm wastes as annually 750,000 tons, not more than a beginning has been made. The chemistry of the utilization of agricultural products and by-products or wastes is still in its infancy."

Giant Power Tunnel Opened in Korea

A tunnel sixteen miles long has just been completed through the mountains of Northern Korea, placing in service the first unit in the construction of a great power development which will cost more than 40,000,000 yen and will divert eastward into the Sea of Japan a large stream which has hitherto flowed north into the Yalu River.

This project, which is entirely financed by the Mitsubishi Company of Tokio, will furnish 102,000 kw. of power, all of which will be used to run a plant to be built at the City of Kanko for the manufacture of nitrogenous fertilizer.

After being brought under the mountain watershed from a great reservoir just completed on the western slope of the range, the stream will furnish a daily average of 660 cu.ft. of water a second. The precipitous nature of the country provides a total drop of 3,326 ft. which will be utilized by a succession of dams and power plants. The power-plant machinery is already ordered from America, and the first unit, to furnish 50,000 kw., will be completed by midsummer of next year.

The Mitsubishi Company is now plan-

ning a similar development on a slightly smaller scale in the same region, and will use the power from the second project for a large chemical factory.

Future A.S.M.E. Plans Announced

Tentative plans are now ready for the Knoxville Meeting of the American Society of Mechanical Engineers, to be held March 21-23, 1929. The program will include papers on important engineering problems, visits to the rapidly expanding industries of the region, as well as trips to places of scenic beauty. The subjects of the technical program are to be water-power development, light-metal industries, coal carbonization, executive training, and the resources of the Southern Appalachian area. As a special attraction a trip will be provided to Kingsport, Tenn., the miracle city of the South, which ten years ago was a bare mountain village, but now has the largest plant in the world making complete books, a wood byproduct plant, a glass works, textile mills and a cement plant.

Plans have also been outlined for the semi-annual meeting in Salt Lake City, July 1-4, 1929. The important feature of this meeting is to be the elaborate scheme of excursions. The copper mines and smelters, the Great Salt Lake, and the canyons near the city will provide an exceedingly interesting four days. The program of papers will deal with aëronautical development, the smelting industry, low-grade copper mining and possibly the beet-sugar industry.

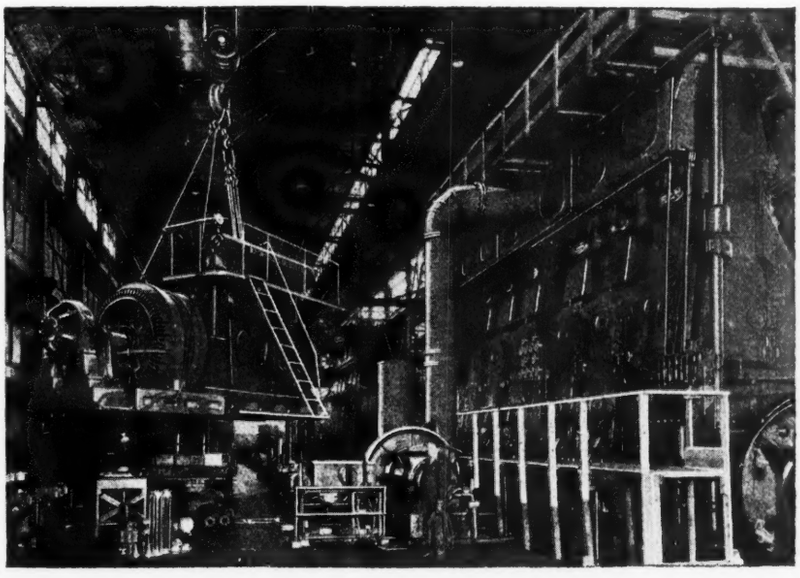
Still another preliminary plan concerns the so-called Six-National-Park Tour arranged to coincide with the Salt Lake meeting in July. The schedule will include the six largest and most important National Parks, namely, Rocky Mountain Estes Park, Grand Canyon, Zion Canyon, Bryce Canyon, Yellowstone Park and Glacier Park. In addition, the itinerary will include such scenic wonders as the Royal Gorge, the Hanging Bridge, Colorado Springs, Glenwood Springs, Pike's Peak, Garden of the Gods, the famous Colorado Million-Dollar Highway and Niagara Falls.

As the tour is now planned, it will take 30 days and cover approximately 8,000 miles. Of these, sixteen days will be spent in the Parks, and four in Salt Lake City at the time of the Spring Meeting. Of the mileage 6,000 miles will be by train and 2,000 by automobile. It will take in sixteen states of the Union and the Dominion of Canada.

The tour is to be arranged on the all-expense plan and the minimum cost per person will be approximately $585 from New York and return.

Plastic Bearings Tested

Plastic bearings have proved successful in submarine engines, according to experiments conducted by the Bureau of Engineering, Navy Department. In order to reduce the risk of bearings seizing or burning out owing to improper clearance adjustment, unequal expansion or insufficient oil, these high lead content bronzes were tried. One brand proved up without oil at a shaft speed sufficient to melt high-temperature white metal. The shaft was not seized and after stopping could be started again. No wiping of the bearing occurred and apparently no wear.



FAST WORK in engine building at the plant of the Busch-Sulzer Company in St. Louis. In the sling is a 225-hp. Diesel built for the U. S. Government in less than 70 days. The large engines are 3,900-hp. Diesels for the U. S. Shipping Board.

Spot * News

A PROJECT *to develop 40,000 hp. from the Cumberland River near Cumberland Falls, Ky., is being opposed on the ground that the scenic beauty of the falls will be destroyed if power is generated there. Governors and Congressmen are taking an active part in the debate.*

* * *

ALABAMA POWER COMPANY *has begun the construction of a $1,000,000 steam plant to furnish power to the International Paper Company's plant near Birmingham, Ala.*

* * *

A NEW TURBINE-ELECTRIC LINER *of 14,300 tons displacement is under construction at Camden, N. J., for the Grace Steamship Company, and will be ready for the South American trade during the coming year. Her twin 6,300-hp. G.-E. turbines and motors will give her a speed of nineteen knots, it is estimated.*

* * *

A MERGER *of ten Maine power firms with the Gould Electric Company has been authorized by the Public Utilities Commission of that state.*

* * *

CLARENCE G. FRANK, *a junior engineer at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company, received the student's award for 1928 from the A.S.M.E. for his paper, "Condition Curves and Reheat Factors for Steam Turbines." The award was made at the annual dinner of the society in New York City.*

* * *

THE FEDERAL POWER COMMISSION *has received an application from the Inland Power & Light Company, of Portland, Oregon, for a permit to develop 233,000 hp. on the Lewis River in Washington. Four dams are projected.*

* * *

THE DEARBORN CHEMICAL COMPANY, *of Chicago, is broadcasting talks each evening in December at 7:45 from Station WWAE, on the subject of feed-water treatment.*

* * *

THE PEOPLE OF WINNIPEG, *Canada, have approved a $6,500,000 money by-law providing for the development of the Slave Falls power site on the Winnipeg River. The project, which will be carried out by the Winnipeg Hydro Commission, is expected to reach an ultimate total of 100,000 hp.*

Central Maine Project Started Near Bingham

Preliminary work has been started by engineers of the Central Maine Power Company on its projected development of the hydro-electric resources of the Kennebec river, near Bingham, Maine.

For some time, the company has owned a site on the Kennebec river above the town of Bingham. Actual work on the construction of a 100-foot dam to impound the waters of the Kennebec at this point will begin in the near future, and it is expected that the new dam will begin to fill with water in the spring of 1931. Final tests for foundations, stress and other preliminaries are proceeding rapidly. Offices and camps have been erected for preliminary workers and a railroad is being constructed to tap the Maine Central at Bingham.

The head of water which the Kennebec river offers at this location will be sufficient, it is estimated, to generate approximately 60,000 horsepower. It will provide a material increase in the company's generating facilities and will anticipate by several years the growth of the adjoining territory.

Power Permit Applications

Several requests for preliminary permits have been received lately by the Federal Power Commission at Washington. Among the projects contemplated are, a 2,000-hp. development on the Kalamazoo River in Michigan; a 16,000-hp. development in Trinity County, California, which includes a dam 300-ft. high across the Eel River; and a 111,000-kw. project on Strawberry and Onion Creeks in Grant County, Oregon. Various other minor developments have been planned and permits asked.

OBITUARY

ANDREW JACKSON DECAMP, for more than forty years general manager of the Philadelphia Electric Company, died at his home in Philadelphia on Dec. 11 of pleurisy after an illness of three days. He was in his 87th year. As general manager of the Brush Electric Light Company at Philadelphia, 1881, Mr. DeCamp supervised the electric lighting of Chestnut Street, which attracted excursionists from all parts of New Jersey and Pennsylvania, since the city was the second in the country to light one of its streets with electricity. When the various neighborhood companies that now form the Philadelphia Electric Company were merged, Mr. DeCamp continued as general manager. Although he had not been active for the last ten years he did not formally retire until last July.

Mr. DeCamp was a Civil War veteran, and one of the founders of the National Electric Light Association.

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Engineering Institute of Canada, annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

PERSONALS

MAJ. FRANCIS K. NEWCOMER has been appointed assistant chief engineer of the Federal Power Commission. Major Newcomer comes to the Commission after a tour of duty as an instructor at the Army Engineer school. He also served five years at West Point as associate professor of mathematics.

C. E. GEORGE, for many years Western manager of the American Schaeffer & Budenberg Corporation, Brooklyn, N. Y., has recently joined the sales staff of the Taylor Instrument Companies of Rochester, N. Y. He will be associated with the Chicago office of the company with headquarters at 58 East Washington St., Chicago, Ill.

W. B. MARSHALL has recently been appointed sales manager of the contract engineering department of the Chain Belt Company, Milwaukee, Wis. He has been associated with the company since 1921, when he was graduated from the Sheffield Scientific School of Yale University.

PAUL R. DUFFEY, for several years identified with the Celanese Corporation of America as electrical and power engineer, and of recent months with the engineering department of the Industrial Rayon Corporation, of Cleveland, Ohio, has been appointed works engineer of the latter company's new factory being built at Covington, Virginia.

BUSINESS NOTES

THE BOTFIELD REFRACTORIES COMPANY, Philadelphia, Pa., announces that McCarthy-Jones & Allen Company, Inc., 111 First Avenue, South, Nashville, Tenn., has been appointed a distributor for all Botfield products.

WAGNER ELECTRIC CORPORATION, of St. Louis, Mo., announces that Paul F. Forsyth has been appointed to the position of branch manager of its Cincinnati office.

THE NATIONAL FLUE CLEANER COMPANY, INC., of Groveville, N. J., has recently appointed the following western agents to handle the National Soot Blower for fire tube boilers: McGee

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25@$2.50
Kanawha	Columbus	1.25@ 1.45
Smokeless	Cincinnati	2.25
Smokeless	Chicago	1.75@ 2.00
S. E. Kentucky	Chicago	1.25@ 1.50
Steam	Pittsburgh	1.50@ 1.75
Gas Slack	Pittsburgh	.80@ 1.00
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50@ 3 25
Barley	New York	1.00@ 1.75

FUEL OIL

New York—Dec. 13, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis — Dec. 6, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3709 per bbl. or 42 gal.; 26@28 deg., $1.4209 per bbl.; 28 @ 30 deg., $1.4709 per bbl.; 30 @32 deg., $1.5209 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., 5.355c.

Pittsburgh—Dec. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5½c. per gal.

Philadelphia—Dec. 11, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati—Dec. 4, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Dec. 8, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

Boston—Dec. 10, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.56c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Dec. 1, f.o.b. local refinery, 26@30 deg., $1.20 per bbl. or 42 gallons.

Sales Agency, 75 Fremont St., San Francisco, Calif.; Flickinger, Meyers & Rudolph, 129 W. Second St., Los Angeles, Calif., and the Manufacturers Sales-Service, P. O. Box 655, Salt Lake City, Utah. W. A. Ramsay, Ltd., of Honolulu, has been appointed representative for Hawaii.

THE FOOTE BROS. GEAR & MACHINE COMPANY, Chicago, Ill., announces that it has acquired an interest in the following four concerns: Lyle Culvert and Road Equipment Company, Stockland Road Machinery Company, Northwestern Steel & Iron Corporation, all of Minneapolis, Minn., and the Bates Manufacturing Company, Joliet, Ill.

TRADE CATALOGS

AUTOMATIC SWITCHING EQUIPMENT—Bulletin GEA-153A has been issued by the General Electric Company, Schenectady, N. Y., to bring out some of the salient features of automatic control as applied in hydraulic power plants. The four pages of the publication contain installation photographs, a single-line wiring diagram, and explanatory layout drawings.

BOILERS—The Erie City Iron Works, Erie, Pa., has issued a sixteen-page bulletin entitled "Erie City Economic Boiler." The bulletin illustrates a moderate-sized heating boiler, and is mainly concerned with giving installation photographs.

INDUCTION MOTORS—Polyphase induction motors from ¼- to 200-hp. are illustrated and described in Bulletin 1118-E issued by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The illustrations show the construction of the motors, their salient parts and methods of lubricating and cooling. Auxiliary equipment is also shown.

AUTOMATIC HYDRO STATIONS—A bulletin on automatic hydro-electric stations has been issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburgh, Pa. The bulletin consists of sixteen pages, in which a complete description of automatic apparatus is included, together with a discussion of the various auxiliary parts, all carefully illustrated.

With the Society Sections

American Engineering Council, annual meeting, to be held in Washington, D. C., Jan. 14-15, 1929, at the Mayflower Hotel.

A. S. M. E., Knoxville Regional Meeting. Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Hartford Section. Meeting at the Hartford Electric Light Company's auditorium Dec. 18. Subject: Opportunities for Public Service Usefulness, by Samuel Ferguson, president, Hartford Electric Light Company.

American Water Works Association, New York Section. Meeting, Dec. 28, at the Hotel Pennsylvania. This will be a luncheon meeting.

American Water Works Association, Kentucky-Tennessee Section. Annual meeting, to be held at Chattanooga, Tenn., Jan. 24-26, 1929.

National Marine Engineers Benefit Association. The 54th annual meeting will be held in Washington, D. C., Feb. 11-16, at the Hotel Hamilton.

Engineers' Club of St. Louis. Meeting Feb. 13, 1929. Subject: "Steam Storage and Steam Distribution," by R. A. Longworthy, vice-president and general manager of Ruths Accumulator Company.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Little Rock—Arkansas Cold Storage Co., C. E. Rose, Pres. and Gen. Mgr., awarded contract for addition to cold storage plant at ft. of Rock St. to Dickerson & Veasey, Little Rock.

Ark., Nashville — Southwestern Gas & Electric Co. plans extensions and improvements to waterworks including well, pump, etc., also rehabilitate electric distribution system. A. Patterson, c/o owner, is chief engineer. Work will be done by owner's forces.

Colo., Denver—City and County, will receive bids until Dec. 31 for the construction of a 5 story court house and city hall, including separate boiler house at Bannock St. between West 14th and West 15th Sts. Estimated cost $5,000,000. Allied Architects, Insurance Bldg., are architects. Former contract rescinded.

Conn., Bridgeport—Southern New England Telephone Co., 157 Church St., awarded contract for foundation for a 10 story exchange building on Courtland St., to E. & F. Construction Co., 94 Wells St. Estimated cost $3,000,000.

Conn., Stamford—Shippan Point Hotel Corp., c/o C. Adams, 2038 Spruce St., Philadelphia, Pa., Archt., is having preliminary plans prepared for the construction of a 16 story hotel. Estimated cost $4,000,000.

Conn., West Hartford — St. Thomas Seminary, awarded contract for the construction of a central heating plant to W. H. O'Neill. Estimated cost $25,000.

D. C., Washington—M. & R. B. Warren, 917 16th St. N. W., are having plans prepared for the construction of three apartment buildings at Connecticut Ave. and Sedgwick and Tilden Sts. N. W. Estimated cost $3,000,000. Parks & Baxter, 1800 E St. N. W., are architects.

Illinois—Union Electric Light & Power Co., 315 West 12th Blvd., St. Louis, Mo., has work under way on extensions and improvements to steam power plants at Cahoila and Venice, Ill. Estimated cost $2,100,000.

Ill., Chicago—Chicago Board of Trade will soon award contract for a 44 story office and board of trade building at Jackson Blvd. and La Salle and Sherman Sts. Estimated cost $8,000,000. Holabird & Root, 333 North Michigan Ave., are architects.

Ill., Chicago — Syndicate, c/o H. G. Holsman, 307 North Michigan Ave., Archt., is having plans prepared for the construction of a 13 story apartment building, including refrigeration system, elevators, etc., at 1321 East 56th St.

Ill., Chicago—Syndicate, c/o Leichenko & Esser, 38 South Dearborn St., Archts., will soon award contract for the construction of a 21 story apartment building at 1638 East 50th St. Estimated cost $1,500,000.

Ind., Michigan City — Northern Indiana Public Service Co., 649 Hohman St., Hammond, is having plans prepared for the construction of an electric generating station here. Estimated cost $1,000,000. Sargent & Lundy, 72 West Adams St., Chicago, Ill., are engineers.

Ia., Hornick — City, J. C. Clark, Clk., will soon award contract for waterworks improvements, including deep well, pump house, pumps, etc. W. E. Buell & Co., Grain Exchange Bldg., Sioux City, are engineers.

Kan., Long Island — City, I. C. Young, Clk., will soon award contract for waterworks improvements, including pump house, 30,000 gal. tank on 110 ft. tower, etc. Shockley Engineering Co., 800 Graphic Arts Bldg., Kansas City, Mo., is engineer.

Kan., Prairie View—City, B. Finch, Clk., will soon award contract for waterworks improvements, including pump house, tank on tower, etc. Estimated cost $17,000. Shockley Engineering Co., 800 Graphic Arts Bldg., Kansas City, Mo., is engineer.

Kan., Topeka—Virginian Arms Holding Co., c/o H. M. Guy, 320 West First St., will receive bids about Jan. 1 for the construction of a 10 story apartment building, including steam heating system, etc., at 10th and Topeka Aves. Estimated cost $750,000. Bowling & Shank, 1198 Arcade Bldg., St. Louis, Mo., are architects. W. J. Knight & Co., 902 Wainwright Bldg., St. Louis, Mo., are engineers.

Kan., Wichita—Medical Arts Building Co., c/o J. H. Engstrom, Pres., 117 North Hondley St., is having preliminary plans prepared for a 16 story office building including steam heating system, etc., at Douglas and Webb Aves. Estimated cost $500,000. A. Boyer, Arcade Bldg., St. Louis, Mo., is architect.

Ky., Covington—Covington Hotel Co., J. A. Wakeman, Pres., will build an 8 story hotel, including steam heating system, etc. Estimated cost $1,000,000. Work will be done by separate contracts under the supervision of Preston J. Bradshaw, 718 Locust St., St. Louis, Mo., Archt.

Md., Baltimore — St. Mary's College, is receiving bids for the construction of a power house. Maginnis & Walsh, Statler Bldg., Boston, Mass., are engineers.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., is having plans prepared for the construction of a 14 story addition to office building, Bigelow, Wadsworth, Howland & Smith, 11 Beacon, are architects.

Mass., Boston — Massachusetts General Hospital, Fruit St., is having revised plans prepared for an 11 story hospital. Estimated cost $1,500,000. Coolidge, Shepley, Bulfinch & Abbott, Ames Bldg., are architects.

Mass., Quincy—Quincy Electric Light & Power Co. awarded contract for the construction of a power sub-station at Town River Bay to New England Power & Construction Co., 89 Broad St., Boston. Estimated cost $40,000.

Mich., Detroit—Duns Scotus, Franciscan Friars, Cincinnati, O., awarded contract for the construction of a college at Nine Mile Rd. and Evergreen Rd. here, to W. E. Wood Co., 1805 Ford Bldg., Detroit, Mich. Estimated cost $1,000,000. Steam heating system, boilers, etc. will be installed.

Minn., Minneapolis — Calhoun Beach Holding Co., c/o S. G. Collins, 203 Lincoln Bank Bldg., awarded contract for the construction of an 8 story club house on Dean Blvd. and West Lake St. to J. A. Hopluch Co., 111 West Washington St., Chicago, Ill. Steam heating system, etc. will be installed.

Miss., Carthage—Bd. of Alderman will soon award contract for waterworks improvements, including pump house, pumps, etc. M. L. Culley, Jackson, is engineer.

Miss., Hattiesburg—Forrest Hotel Co., c/o Chamber of Commerce, will soon award

contract for an 8 story hotel including steam heating system, etc. at Forrest and West Pine Sts. Estimated cost $500,000. G. D. Barnett, 913 Syndicate Trust Bldg., is architect. B. C. Hearon & Son, 201½ West Pine St., is associate architect.

Miss., Oxford—University of Mississippi, c/o Mississippi State Building Commission, W. C. Trotter, Secy., Jackson, will readvertise for bids soon for the construction of a cafeteria building and pump house, here. F. P. Gates, Edwards Hotel Bldg., Jackson, is architect.

Mo., St. Louis—Paramount Construction Co., J. A. Pastel, Pres., 904 Chestnut St., will build two 13 story apartment buildings including steam heating system, etc. one at 4436 Lindell St. and other at 4440 Lindell St. Estimated cost $2,000,000. McDonald & Condie, 502 North Taylor Ave., are architects. Work will be done by separate contracts.

Mo., St. Louis—John M. Robertson, Boatmen's Bank Bldg., plans the construction of a 40 story office building at 4th and Olive Sts. Estimated cost $3,500,000. Eames & Young, Arcade Bldg., are architects.

Mo., St. Louis—Syndicate, c/o C. P. Heath Real Estate Co., 818 Chestnut St., will receive bids about Jan. 15 for the construction of an 8 story apartment building including steam heating system, etc. at Pershing and Taylor Aves. Estimated cost $800,000. T. P. Barnett Co., 1559 Arcade Bldg., are architects.

Neb., Central City—City, F. Heaton, Clk., awarded contract for the waterworks improvements, including pumping plant, mains, etc., to A. A. Dobson Co., 824 First National Bank Bldg., Lincoln. Estimated cost $74,057.

N. J., Bayonne—Bd. of Commerce, City Hall, will soon award contract for the construction of a 4 story municipal building including steam heating and ventilation systems, boilers, elevators, etc. at 27th and 28th Sts. and Ave. C. Estimated cost $1,000,000. P. A. Vivarttas, 110 48th St., Union City, is architect.

N. J., Belleville—Bd. of Chosen Freeholders, Hall of Records, Market St. and Springfield Ave., is having revised plans prepared for the construction of an 8 story hospital including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. at County Isolation Grounds. Estimated cost $1,000,000. Sutton, Sutton, & Calkins, 402 Broad St., Newark, are architects. Runyon & Carey, 31 Fulton St., Newark, are consulting architects. Former bids rejected.

N. J., Jersey City — Delaware, Lackawanna & Western R.R. Co., Hoboken Terminal, Hoboken, awarded contract for the construction of a 1 and 8 story warehouse and freight terminal including steam heating and ventilation systems, boilers, elevators, etc., at Grove St. and Jersey Ave., here, to Turner Construction Co., 420 Lexington Ave., New York, N. Y. Estimated cost $4,500,000. G. J. Ray is chief engineer.

N. J., Newark—B. Leibal, 250 Badger Ave., is having plans prepared for the construction of an ice plant at 230-270 Badger Ave. Estimated cost $75,000. Private plans.

N. Y., New York—Bricken Construction Co., 1385 Broadway, will build a 48 story office building at Broadway and 41st St. Estimated cost to exceed $5,000,000. Buchman & Kahn, 2 Park Ave., are architects. Work will be done by separate contracts.

N. Y., New York—J. Garry, 70 5th Ave., will soon receive bids for the construction of an apartment building at 51 5th Ave. Estimated cost $1,000,000. T. W. Lamb, 644 8th Ave., is architect.

N. Y., New York—George L. Ohrstrom Co., 44 Wall St., plans the construction of a 40 story office building at 34 to 38 Wall St. H. Craig Severance, 36 West 44th St., is architect.

O., Akron—Burkhardt Consolidated Co., 519 Grant St., awarded contract for the construction of an ice plant to Higley Construction Co., 714 North Main St. Estimated cost $200,000.

O., Toledo—Stevens Hotel Co. awarded contract for the construction of a 12 story hotel on Jefferson St., to H. J. Spieker & Co., 1418 Elm St. Estimated cost $1,000,000. Steam heating, ventilation and refrigeration systems, boilers, elevators, etc., will be installed.

O., Wooster — Wooster College, D. F. Wishart, Pres., plans the construction of a group of college buildings, including power plant, etc. Estimated cost $750,000.

Ore., Portland — Northwestern Electric Co., Pittock Bldg., will receive bids about Dec. 15 for addition to power plant on Lincoln St. and River. Estimated cost $1,200,000. Private plans.

Ore., Portland—Pacific States Investment Co., Macleay Bldg., is having plans prepared for the construction of a 24 story office and stores building including steam heating and ventilation systems, boilers, pumps, elevators, etc. at Third and Colder Sts. Estimated cost $1,250,000. Claussen & Claussen, Macleay Bldg., are architects.

Pa., Erie—Erie Dry Goods Co., will soon award contract for a 6 story department store including steam heating and ventilation systems, elevators, etc. Estimated cost $750,000. Shutts & Morrison, Marine Bank Bldg., are architects.

Pa., Pittsburgh—Presbyterian Hospital Association is having plans prepared for the construction of a 10 story hospital at 5th Ave. and Darragh St. Estimated cost $6,000,000. E. P. Mellon, Oliver Bldg., is architect.

Tex., Cotulla—La Salle County Improvement Dist. 1, J. W. Willson, Pres., Bd. of Directors, awarded contingent contract for the construction of an irrigation system to include pumping units, complete system of canals, etc., also one large dam, nine miles north of Cotulla and three smaller dams at other points to Trinity Farm Construction Co., Dallas. Estimated cost $4,500,000.

Tex., Raymond — Farmers Gin Co., recently incorporated, plans the construction of an electrically operated cotton gin. Estimated cost $45,000. Private plans.

Tex., San Antonio—Crystal Ice Co., Hackberry and High Sts., plans the construction of an 18 ton addition to ice plant. Estimated cost $35,000.

Wis., Milwaukee — J. R. Freuler, 216 West Water St., plans the construction of a 12 story hotel including steam heating system, elevators, etc. on Second St. Estimated cost $2,000,000. Dick & Bouer, 208 3rd St., are architects.

B. C. Vancouver—G. A. Stimson & Co., Ltd., 801 Hastings St. W., plans the con-Barnard and Hastings Sts. Estimated cost $1,500,000. McCarter & Nairne, 807 Northwest Bldg., are architects.

Ont., Niagara Falls — General Brock Hotel Co., Ltd., awarded contract for the construction of a 10 story hotel to Pigott Construction Co., Ltd., 4 Hughson St. S., Hamilton. Estimated cost $1,000,000. Steam heating system, elevators, etc. will be installed.

Ont., Niagara Falls—Water Commission, A. Collins, 981 Jepson St., Chn., voted $500,000 bonds for waterworks improvements, including filtration plant, pumping station, etc. F. A. Dallyn, 71 King St. W., Toronto, is engineer.

Que., Montreal — City awarded contract for the construction of a pumping station at McTavish St., to Atlas Construction Co., Ltd., 37 Belmont St. Estimated cost $762,091.

Que., St. Jerome—Regent Knitting Mills Ltd., 1202 St. Law Bldg., Montreal, plans the construction of a water power development on North River here. Estimated cost $65,000.

Equipment Wanted

Boilers, Stokers, Generator Units, Pumps, etc.—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., will receive bids until Dec. 27 for 400 hp. steam boilers, underfeed stokers, 187 kva. generator units, boiler feed, condenser and vacuum pumps, open boiler feed water heater, domestic hot water heaters, etc., for proposed 97 x 109 ft. power house at Apple Creek, O. Estimated cost $57,900.

Motor, etc.—Dow & Co., 2115 Ave. C, Galveston, Tex., is receiving bids for a 15 hp. a.c. electric motor, etc.

Pumping Units — West Side Irrigation Dist., Tracy, Calif., J. C. Chrisman, Secy., plans the installation of pumping units, etc., in connection with canal system. Estimated cost $50,000.

Refrigeration Equipment and Generator —Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Jan. 9 for refrigeration equipment for Utica State Hospital, Marcy, Division, Marcy, and Rochester State Hospital, Rochester, also electric generator for Rome State School, Rome, N. Y.

Industrial Projects

Ala., Birmingham — BOLT and NUT FACTORY—Lamson & Sessions Co., 2188 Scranton Rd., Cleveland, O., plans the construction of a factory for the manufacture of bolts, nuts, rivets and cotter pins, here. Estimated cost $500,000 to $700,000.

Ala., Gadsden—BRAID MILL—Alabama Braid Corp., awarded contract for a 1 story, 150 x 326 ft. braid mill to Smallman Construction Co., 1109 5th Ave., Birmingham. Estimated cost $750,000.

Calif., Oakland — PACKING PLANT — Kings County Packing Co., Reedly, awarded contract for the construction of a packing plant, including boiler house, cooling platform, etc., at Russett St. Extension, here, to Austin Co., Russ Bldg., San Francisco. Estimated cost $500,000.

Ill., Barrington—TEA FACTORY—Jewell Tea Co., 5 North Wabash Ave., Chicago, is having preliminary sketches made for a 2 and 5 story, 100 x 400 ft. tea factory for the manufacture of breakfast foods, extracts, soaps, laundry products, etc., here. Estimated cost $1,000,000. Holabird & Root, 333 North Michigan Ave., Chicago, are architects.

Ill., East St. Louis—FLOUR MILL—Always-A-Head Mills Inc., 35th St. and Southern Ry., awarded contract for a 6 story, 60 x 140 ft. flour mill, elevator section will contain nineteen bins, 40,000 bu. capacity, and manufacturing section, thirty-seven work bins 40,000 bu. capacity, to Humphries Contracting Co., Pierce Bldg., St. Louis.

Md., Baltimore — FACTORY (BAKERS' UTENSILS)—E. Katzinger & Co., 1949 North Cicero Ave., Chicago, Ill., will soon award contract for a 2 story, 140 x 180 ft. factory, here. Estimated cost $200,000. Lockwood, Greene & Co., 40 North Michigan Ave., Chicago, Ill., are architects and engineers.

Mass., East Pepperell — VALVE BAG FACTORY—Cornell Multi-Wall Valve Bag Co., Chicago, Ill., awarded contract for a 1 story, 100 x 160 ft. factory here, to H. L. Shattuck Inc., 208 South St., Manchester, N. H.

Mich., Detroit — MOTOR FACTORY — Caille Bros., Second and Amsterdam Aves., will soon award contract for a 2 story, 86 x 120 ft. factory for the manufacture of outboard marine motors at Second and Amsterdam Aves. Estimated cost $55,000. Donaldson & Meier, 1188 First National Bank Bldg., are architects.

Mich., Detroit—TOOL FACTORY—Lane, Davenport & Peterson, Charlevoix Ave., Engrs., will receive bids about Dec. 10 for a 1 story, 120 x 125 ft. tool factory on Woodrow Wilson Ave. for Gorham Tool Co., 2206 12th St.

Mich., Detroit—CAR STORAGE BUILDING—Packard Motor Car Co., East Grand Blvd., awarded contract for a 2 story, 130 x 380 ft. addition to car storage building on Beaufait Ave., to Everett Winters Co., 1651 East Grand Blvd. Estimated cost $200,000. Steam heating and elevating and conveying equipment for automobile bodies will be installed.

Mich., Detroit — ELECTRICAL APPLIANCE FACTORY — Square D. Co., 6060 Rivard St., awarded contract for a 3 story electrical appliance factory on Russell St., to W. E. Wood Co., 1805 Ford Bldg. Estimated cost $100,000. Steam heating, electric motors and equipment for making safety switches will be installed.

Mich., Northville — AIRPLANE FACTORY — Stinson Aircraft Corp. is having plans prepared for a 1 story, 180 x 300 ft. factory. Estimated cost $150,000. F. J. Winter, 2112 Book Tower, is architect. Owner is in the market for steam heating system, electric motors and general equipment for manufacturing airplanes.

Pa., Coatesville — CARBONIZATION PLANT—International Combustion Engineering Corp., 200 Madison Ave., New York, N. Y., will build a coal carbonization plant here. Estimated cost $1,000,000. Work will be done by separate contracts.

Pa., Marcus Hook—PHOSPHORIC ACID PLANT — General Chemical Co. awarded contract for a 1 story phosphoric acid plant, filter house and oil storage building, to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $100,000.

Ont., Fort William — COKE and GAS PLANT—National Utilities Corp., Winnipeg, Man., plans an election in January to vote $500,000 bonds for the construction of a gas and coke plant, here.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE market for flexible cord, which showed downward movements throughout October and November, has recovered, with current prices on this material substantially above those of a month ago. Rubber-covered copper wire also is higher. Among the metals, babbitt is at present an indicator of the general direction, with advances of 2¾c. per lb. over November quotations. Discounts on enclosed knife switches are larger, marking the only decline of importance to occur this month among electrical supplies. Minor reductions also affected wiping cloths and linseed oil.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply $0.30	4 ply $0.36

Steam—Discounts from List

First grade 40%	Second grade 45%	Third grade	50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium grade	30-10%
Medium grade, heavy weight	30@5%

RAWHIDE LACING—For cut, best grade, 30@5%; 2nd grade, 45@5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots of 250 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.17
New York	.16@.16½
Cleveland (*per thousand*)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.108	$0.11	$0.112

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including $\frac{7}{16}$-in. dia., list (Apr. 1, 1927) less 50-10% in ful packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., per 100 lb.:
New York $5.00* Chicago $3.60 Pittsburgh mill $2.80@$2.90

Cone-head boiler rivets,, ½-in., per 100 lb.:
New York $5.00* Chicago $3.60 Pittsburgh mill $2.80@$2.90

*Price is for full packages; broken package lots, $6.50 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	69.50
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3½	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2½ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$31.00 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23.07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.13	56.40	19.41	21.01
1½	355.50	388.85	82.03	92.28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$18.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13.00
No. 16 cotton reinforced light		18.00
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard Package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.10	$8.30	$10.25	$17.80
12	9.20	10.80	12.70	23.00
10	12.60	14.40	16.50	30.50
8	18.30	20.10	21.40	42.10
6	.....	.....	32.50	.....
4	.....	.....	45.00	.....
2	.....	.....	63.80	.....
1	.....	.....	86.20	.....
0	.....	.....	103.00	.....
00	.....	.....	124.30	.....
000	.....	.....	148.00	.....
0000	.....	.....	180.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots.... 29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots.... 31c per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	35%
$50.00 list value or over	40%